# *Ranch Day*

## OCTOBER 8, 1956

New Mexico Experiment Station, New Mexico Extension Service,
and
Agricultural Research Service,
Rocky Mountain Forest and Range Experiment Station, Forest Service,
U. S. Department of Agriculture

Experimental Ranch
New Mexico College of A & M A

Jornada Experimental Range
Agricultural Research Service

PROGRAM
SIXTEENTH ANNUAL RANCH DAY
Jornada Experimental Range and College Ranch
October 8, 1956
Ivan Watson, New Mexico Extension Service, Presiding

8:00 a.m. Leave Dona Ana County Courthouse, Las Cruces, N. Mex.

8:35 Stop 1 Jornada Experimental Range, Pasture 6

The Use of Electric Fence Enclosure on Tobosa Range--
Fred N. Ares

9:30 Stop 2 Jornada Experimental Range, Pasture 13

Control of Young Mesquite on Southwestern Ranges --
Fred H. Tschirley
Cholla Cacti -- S. Clark Martin

10:30 Stop 3 Jornada Experimental Range

Reproduction and Life Span of Some Southwestern Range
Grasses -- Elbert H. Reid
The Effect of Climate and Grazing on Black Grama --
Harold A. Paulsen

11:30 Lunch Jornada Experimental Range Headquarters

12:45 p.m. Welcoming Remarks

Representative, Agricultural Research Service
Elbert H. Reid, Chief, Range Management Research, Rocky
Mountain Forest and Range Experiment Station
Dr. R. B. Corbett, President, New Mexico College of
Agriculture and Mechanic Arts

1:00 Address by Phil Harvey, Vice President, New Mexico Cattle
Growers Association
Address by Dr. Vernon A. Young, Head, Department of Range and
Forestry, Agricultural and Mechanical College of Texas
Address by Senator Clinton P. Anderson of New Mexico

2:40 Stop 4 College Ranch

The Creosotebush Problems in New Mexico-- James Anderson
Forage Production and Appraisal on Southwestern Ranges--
K. A. Valentine

3:40 Stop 5 College Ranch, Camp Well

Records of Range Steers Related to Feed Lot Gains and
Carcass Merit -- Robert L. Blackwell
Effect of Drought on the Weight and Production of Range
Cattle -- J. H. Knox

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JORNADA EXPERIMENTAL RANGE

COLLEGE RANCH

Lunch
Jornada
Headquarters

Camp Well

Mayfield Well

Co-op Well

Yucca En-
closure

Seldon Well

College
Headquarters

South
Well

Summerford
Mt.

To Radium Springs
(Return to Las Cruces)

To Las Cruces

Portion of College Ranch and Jornada Experimental Range showing
Ranch Day Route
1956

1 2 3 4 (Miles)

LEGEND

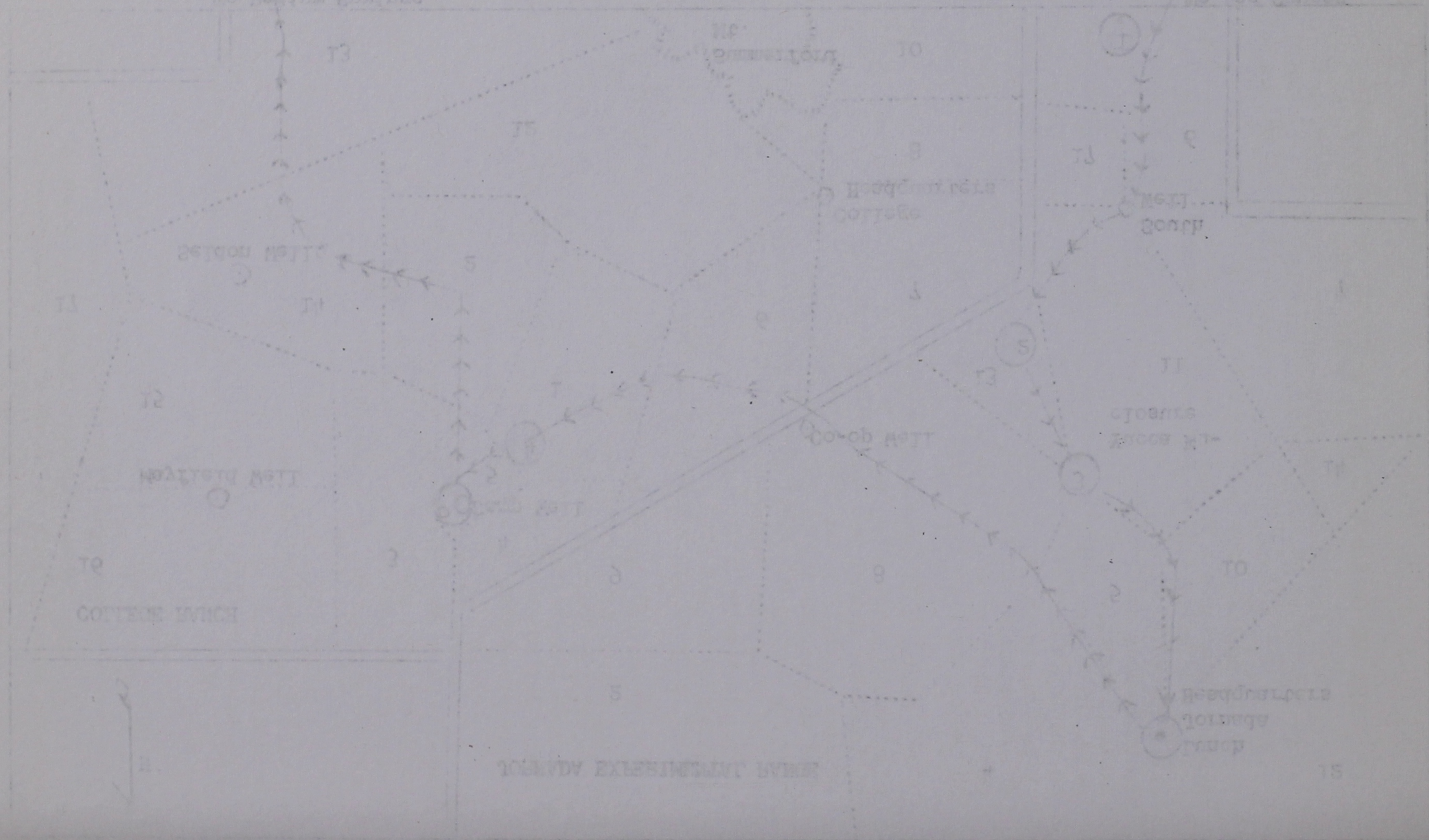
1 Pasture number

Boundary

Division fence

Ranch Day route

Ranch Day stop



# THE USE OF ELECTRIC FENCE ENCLOSURE ON TOBOSA RANGE

Fred N. Ares 1/

On southern New Mexico ranges two major grass types are of primary importance. Tobosa grass (Hilaria mutica) is the dominant and most valuable forage species on the clay flats or swales where water collects periodically during the summer. On lighter, well drained sandy soil, black grama (Bouteloua eriopoda) is the most desirable species and provides most of the forage. Where black grama and tobosa grass occur together the range should be managed on the basis of the black grama, since it is usable and is preferred by cattle over a longer period of time each year. Moreover, growth and maintenance requirements of black grama are such that grazing use must be deferred for a reasonable period, usually during the 3 to 4 months of the summer growing season.

During this summer growing season the desired deferment is obtained by grazing the tobosa summer range. These grasses are relished by cattle, but only when they are green and succulent. If full value is to be obtained from them, they must be grazed before they become dry in the fall. Moreover, frequent and close cropping during the growing period tends to maintain a supply of tender, palatable tobosa forage. If cattle cannot keep up with the rapid growth in the summer, the forage carried over interferes to a marked degree with the utilization of fresh growth. Cattle return to spots which have been cleared of the old growth.

Producing, as it does, an enormous amount of strictly temporary forage over a limited period, the problem then is how to secure, before killing frost, more grazing use of tobosa. This would not only increase the grazing capacity of ranges, but make possible full summer deferment of black grama or other yearlong ranges, and increase production of livestock.

Various methods of increasing tobosa grazing use have been tried. These include temporary water development, salting on the areas and even herding. These have been helpful but all have fallen short of accomplishing the desired results. Usually there is too much surplus growth to be carried over.

In 1955 this area of almost pure tobosa was enclosed by a 2-wire electric fence and tests were made to determine if by this method increased utilization of tobosa could be secured. The fence, 1.23 miles in length, encloses 71.8 acres in this summer range pasture, No. 6. After fencing, and before stocking, a forage inventory

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1/ Range Conservationist, Field Crops Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

was made inside the enclosure by clipping sample plots. After stocking, matching pairs of these sampling plots were clipped to measure the forage volume consumed and thus determine the degree of grazing use in the enclosure.

The enclosure was stocked on August 18, 1955, with 55 head of adult cattle, including bulls. They were weighed when turned into the enclosure, again when taken out on September 12, 25 days later. No rain was received during the period so water had to be hauled from a nearby well to supply the cattle. Salt was placed near the center of the area to secure uniform distribution and grazing use.

In table 1 below are given the results of the 1955 test grazing of the enclosure. Shown are the forage supply before and after grazing, the actual use of the available forage by the 45.8 cow months stocking of the enclosure, and the before and after weights of the cattle.

Table 1.-- Total forage yield, available forage, and degree of utilization in 2-wire electric fence enclosure (71.8 acres). Stocking rate 45.8 cow months.

| | Total forage | | | Forage available* | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hmu | Sbr | Total | Forage available (30%) | Per acre animal unit-days | No. animal months 71.8 acres | Utilization | Avg. cattle weight each |
| | Lb/A | Lb/A | Lb/A | Lb./A | ** | | Pct. | lb. |
| Before grazing | 2,226.3 | 257.6 | 2,483.9 | 745.2 | 29.7 | 71.1 | 0 | 906.0 |
| After grazing, Forage remaining, stocking, weights, etc. | 758.9 | 81.2 | 840.1 | 252.0 | 10.0 | 24.0 | 34 | 932.4 |
| Forage used, Stocking, weights, etc. | 1,467.4 | 176.4 | 1,643.8 | 493.2 | 19.6 | 47.1 | 66 | +26.4 |

* In terms of actual use of available forage. "Available forage" is 30 percent total yield (col. 4).

** On basis of daily ration of 25.1 pounds forage, dry weight per head.

The most important fact to consider about the results of this test is the degree of utilization shown, 66 percent in terms of proper use with 55 head of cattle for 25 days or 45.8 cow months. This is not

the full use of "available forage" hoped for, but it is far better than the usual 20 to 30 percent obtained under open range grazing. The 66 percent utilization for the 25 days means that for the same period 71 head of cattle could have been pastured in the enclosure. This latter degree of stocking would then have obtained full utilization of the "forage available." Following along this line, areas of tobosa grass in pasture 6 could, if fully grazed, support more cattle for the 4-month summer grazing season than does the entire 6,502 surface acres of pasture 6 under present management. As a matter of fact this could even have been accomplished with only the 66 percent utilization obtained in the enclosure.

If it is assumed that full use of tobosa can be secured by the above means and if it is applied to all of the tobosa range in pasture 6, approximately 486 acres, the end results would be gratifying. These areas alone would carry a total of 147.0 cattle for the 4-month summer season. When combined with the value of other areas in the pasture, this would increase the grazing capacity of pasture 6 about 148.4 percent.

Other values of the electric fence enclosure are: (1) Improved breeding conditions. Cows held together with bulls on small areas during breeding season will produce better calf crops. (2) Old growth removed. While proper use of the available forage in the area still was not realized, grazing use was sufficient to remove most of the top growth. This will tend to progressively improve the grazing quality of an area so treated. Surplus forage left over becomes harsh and woody, interfering with subsequent grazing. (3) Cattle protected from poison plants. Held in this enclosure they were kept away from a poison plant area in the vicinity and no losses were incurred. (4) Cattle gain weight. Tobosa grass is proven to be nutritious as well as usable during the summer period. Cattle held in the enclosure made an average daily weight gain of approximately 1 pound each on a diet consisting of nearly all tobosa.

Costs involved in the construction of 1- and 2-wire electric fences are low compared to that of conventional 4-wire fences. At the present time, material and labor costs for the latter will run as high as $800 per mile.

This area of 72 acres is enclosed by 1.23 miles of 2-wire fence. The steel posts are set about 120 feet apart. The wires are stretched by pulling them toward the posts. These are set out of line to make the wire pull away from the post and thus avoid grounding the charged wires. Construction of the fence required 4 man-days labor, 2.46 miles of galvanized barbed wire, and 44 steel posts. In material and labor costs this adds up to $209.14 per mile or a total cost of $257.24 for the fence. This includes cost of electric controller, insulators, etc. The tank was built by a bulldozer in about 5 hours actual work at a cost of $60 for the operator and machine. The tank is sufficiently large to water a much greater area than is enclosed here. The total cost of all construction and material was $317.24.

This improvement cost when prorated to the total weight gain (1,452 pounds for the 55 cattle) is high, about 28 cents per pound. But it must be remembered that this represents initial cost and that this expense with the benefits already mentioned can be spread over many years to come.

# CONTROL OF YOUNG INVADING MESQUITE ON SOUTHWESTERN RANGES

Fred H. Tschirley [1/]

It seems rather strange to speak of the control of young, invading mesquite at a time when so many acres are already fully infested in the Southwest. There is ample justification for spending some time on this problem, however. Mesquite has not yet invaded nearly the full geographic range that it can potentially occupy. Many areas which were good grassland 30 years ago are now mesquite thickets, and this same process of mesquite invasion is still going on. Unless the invasion of mesquite is halted, 50 years from now people will be wondering why those of us living in mid-century didn't realize the seriousness of the mesquite problem and do something to stop its invasion.

There is ample information to prove beyond question that mesquite has many more entries on the debit side of grassland accounting than it does on the credit side. Only a few trees on an acre of rangeland will take money from your pockets. It is during the invasion stages that mesquite does the most damage, but this also is the time when it can be most easily controlled. A good deal of data which I will be presenting has been obtained from the Santa Rita Experimental Range in southeastern Arizona, and the remainder has been obtained from experimental work here on the Jornada Experimental Range. Data from the Santa Rita is not entirely applicable to New Mexico conditions since a different variety of mesquite is involved. The principles of control of young plants are the same, however, and the response of native perennial grasses to mesquite eradication is similar.

I mentioned that only a few mesquite trees per acre are necessary to take money from your pockets. This was shown very clearly by a study which was conducted on the Santa Rita Experimental Range and is summarized in table 1.

Table 1.-- Benefits of mesquite control

| Plot | Trees (No.) | Forage Production (Lb./A) Dry wt. | Lb. beef at 10 lb. grass/lb. beef | Dollars/acre beef 18¢ lb. |
|---|---|---|---|---|
| A | 138 | 44 | 4.4 | 0.79 |
| B | 25 | 120 | 12.0 | 2.16 |
| C | 16 | 160 | 16.0 | 2.88 |
| D | 9 | 198 | 19.8 | 3.56 |
| E | 0 | 234 | 23.4 | 4.21 |

1/Range Conservationist, Field Crops Research Branch, Agricultural Research Service, U. S. Department of Agriculture, Tucson, Arizona.

The lefthand column of table 1 gives the 5 different plots involved. The second column gives the number of mesquite trees per acre. Plot A has the original stand of 138 trees per acre. On Plot B the number of trees was reduced to 25 trees per acre, and then down to 16, 9, and 0 for Plots C, D, and E. This study was established in 1945. Since that time, annual measurements of perennial grass herbage production have been made. We now have 10 years of data from this study. Column 3 gives the average forage production in pounds per acre for each of the 5 plots. The forage production figures represent 50 percent of the total perennial grass which was produced. The fourth column represents the pounds of beef that would be produced, assuming that it takes 10 pounds of grass to produce 1 pound of beef. The last column shows you in dollars and cents how much money the mesquite on your ranges is taking from your pockets. You will notice that there is a considerable difference between the plot having 138 trees per acre and the plot having 25 trees per acre. Approximately the same difference exists between the 25 tree per acre plot and the plot on which the mesquites were entirely removed. If you have a full stand of mesquite you can increase your per acre earning power approximately 5 times by removing that mesquite, but the cost of removal is going to be high. On the other hand, if you have only 25 mesquite trees per acre you can increase your earning power approximately $2\frac{1}{2}$ times and the cost will be very low. In terms of an investment, your dollar will bring a much higher return when it is applied toward control of light stands of mesquite rather than dense, established stands. This relationship is graphically represented in figure 1.

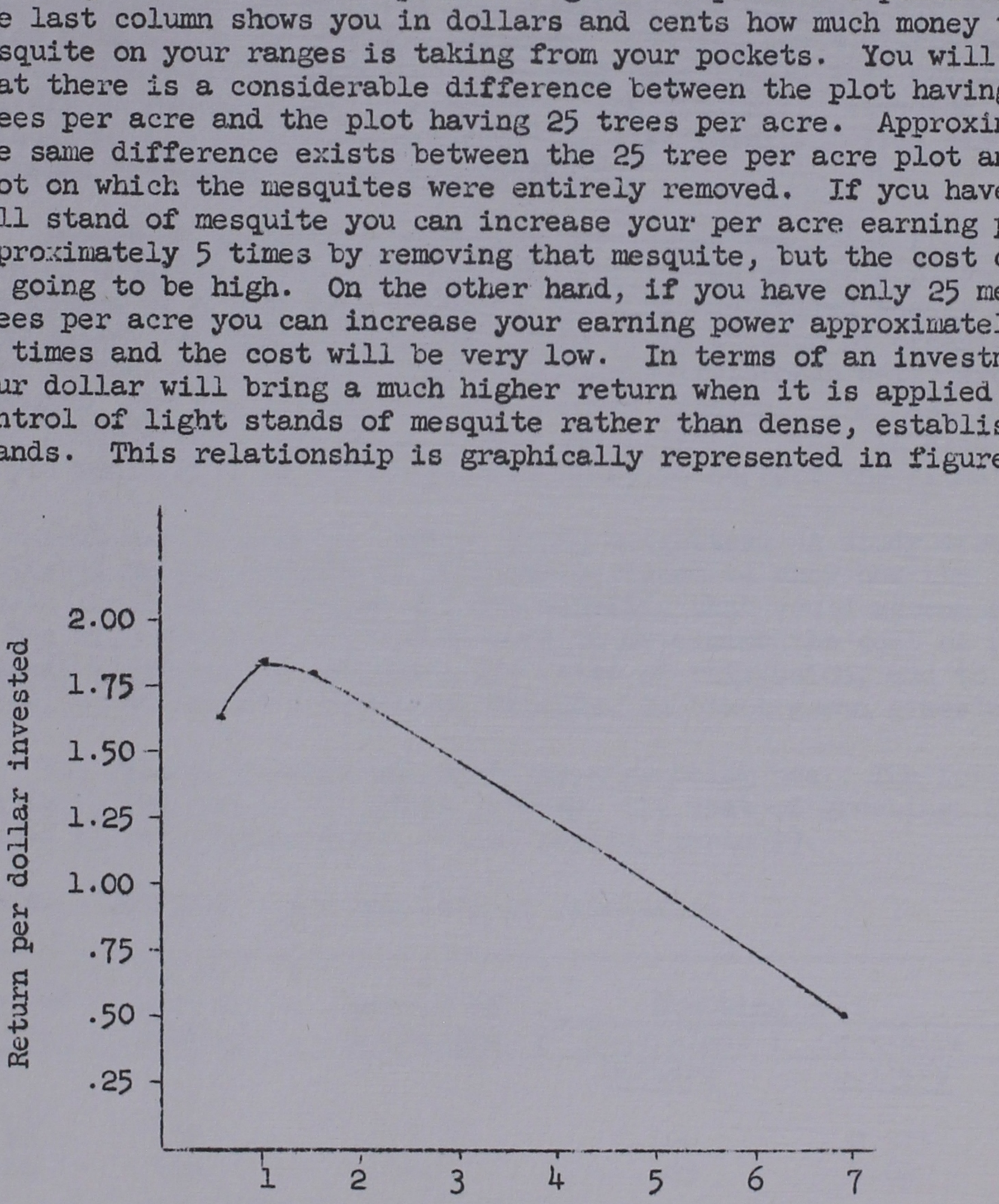


Figure 1.-- Return per dollar invested in mesquite control. Investment costs assume treatment of all trees on acre of land.

Figure 1.-- Return per dollar invested in mesquite control. Investment costs assume treatment of all trees on acre of land.

A little later on I will go into cost figures for controlling young mesquite. The important point right now is to realize that Plot B which has only 25 mesquite trees per acre has reduced the forage production by approximately 50 percent. This means that half of your loss occurs at a time when mesquite is invading. Perennial grass forage is not the only loss, however. Soil fertility is reduced because the buildup of organic matter is much slower under a dense canopy of mesquite than on good grassland. Erosion resulting from the impact of rain on a soil denuded of grass vegetation is another serious problem. Here in New Mexico you are especially concerned with wind erosion which forms the characteristic dunes around a clump of mesquite. If perennial grass were present to hold the soil together you wouldn't see the wind erosion with which you are all familiar. But you can't expect to have mesquite without dune formation, and once established they are very difficult to rehabilitate. In areas of low rainfall, reseeding is difficult in the best years and shifting sand resulting from wind erosion makes reseeding virtually impossible.

Permit me to briefly summarize the losses resulting from the invasion of mesquite. First of all, you are losing valuable perennial grass forage at a time when mesquite could be controlled easily and economically; secondly, there is little or no buildup of organic matter in the soil; third, you are losing soil through water erosion; and fourth, you are losing soil due to wind erosion. The last three losses occur after mesquite is firmly established. This is also the time you would have to spend the most money to correct the situation.

What can be done to control young mesquites? A study area established on the Jornada in 1948 was designed to show how the mesquite could be controlled and the benefits that would accrue from it. The objectives of this study were to determine the cost of removing small mesquites to determine the rates of reinvasion, and to determine the attendant increase or decrease in black grama grassland.

The control measure employed was a grubbing hoe. The following table shows the number of plants grubbed, the cost of grubbing, and the rate of reinvasion over a 7-year period (table 2).

Table 2.-- Grubbing costs and rate of reinvasion

| Study and plot No. | Number plants grubbed | Percent of reinvasion | Grubbing cost | |
|---|---|---|---|---|
| | | | Cost/plant | Cost/acre |
| | | | Dollars | Dollars |
| 48-1-B[1/] | 30 | 13.3 | 0.125 | 0.375 |
| 48-2-B[2/] | 805 | 64.5 | .025 | 4.02 |

1/ 10 acres per plot.
2/ 5 acres per plot.

There are several points of interest in table 2. The rate of reinvasion, for example, was much greater on the area having a heavy stand of mesquite in 1948. The costs per plant rise as mesquite density decreases but the per acre cost remains low. Here again it is well to emphasize the information given in table 1, which showed that 50 percent of the forage production is lost on an area having 25 mesquite trees per acre. This general level of mesquite infestation gives the greatest response in terms of perennial grass forage production and is the most economical to control on a per acre basis.

The use of a grubbing hoe on invading stands of mesquite will work in very well with any management practice. The plants can be grubbed at any time of year. Many small plants can be grubbed as they are spotted while doing routine range riding. In this way, no appreciable amount of time is lost. When carrying a grubbing hoe becomes routine, the cost of control is negligible.

Another well proven method of killing mesquite is spraying the base of each stem with diesel oil. This, of course, won't work on established seedlings where there are hundreds of stems for each plant. It works very well, however, on single- and several-stemmed plants regardless of size. Experience on the Santa Rita has shown that the cost of this method of treatment averages about 5 cents per tree. This method can also be used at any time of year.

I have tried to establish the point that the best place to concentrate efforts on mesquite control is in areas where there is only a light investation. Heavy infestations are important, of course, and thought should be given to reclaiming those lands, but it is in the light infestations that the greatest return per dollar invested can be expected. The grubbing hoe is the oldest method of weed control known, but that does not detract from its usefulness. It requires treating plants individually and is thus well suited to the control of light infestations. As long as a mesquite plant is grubbed below the root-crown the grubbing hoe is always effective, and effectiveness of mesquite control, coupled with economy, is what we are after.

# CHOLLA CACTI

S. Clark Martin[1/]

Cholla or cane cacti are abundant or potentially a problem in many parts of New Mexico and Arizona. Their distribution is by no means continuous, and accurate information has not been compiled on the ranges and acreages. Several cholla species grow in western New Mexico and some occur in eastern New Mexico (fig. 1). In many areas it is a distinct range problem. If cholla on your range appears to be dying out you probably don't have to worry much about its spreading. But if your cholla is vigorous and thrifty, keep an eye on it. It may take over the place.

A few of the species of cholla cacti in Arizona and New Mexico are the mat-like cholla (Opuntia Stanlyi) of southwestern New Mexico and southeastern Arizona, Christmas cactus (O. leptocaulis) of southern Arizona and New Mexico; and staghorn or cane cactus (O. spinosior) of western New Mexico and southern Arizona. The most common species of cholla in New Mexico is O. arborescens. This species, sometimes called tree cactus or tree cholla, is similar in growth form to the staghorn or cane cholla of southern Arizona.

Like many other woody plants, cholla cacti are objectionable on the range because they use water and soil nutrients that are needed for forage production. On the Santa Rita Experimental Range south of Tucson, Arizona, we've found that a stand of cholla reduces grass production by about 10 percent. Because of its spines, cactus also interferes with the use of forage by livestock and causes an undetermined amount of animal discomfort. Dense stands over large acreages make handling livestock difficult. And cactus spines in wool detract from its value. Many species of cholla are able to spread more rapidly than some other woody plants because new plants will grow from stem joints that drop off the parent plant. If a cow, sheep, or horse rubs against a cholla, the joints sticking to his hide may be carried several miles before they are dropped. Livestock can also spread cholla by eating the ripe fruits and planting undamaged seeds in their droppings over the range.

The ability of cholla to spread vegetatively by means of dislodged joints is offset to a degree by its susceptibility to natural enemies. In southern Arizona, for example, we know that jumping cholla (O. fulgida) spreads very fast (fig. 2). At the same time, if we look around we can usually find old stands of cholla that are all but killed out by natural enemies (fig. 3). These natural enemies of cholla may be insects, bacteria, viruses, fungi, or some combination of these factors, together with adverse conditions of climate or soil. In any event, the possibilities for biological control of cholla cacti appear to warrant further study.

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1/ Range Conservationist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

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1\ Forest Conservationist, North Carolina Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

Cholla cactus has been considered a problem on the Santa Rita Experimental Range for many years, and many control methods have been tried. A few of the chemical and mechanical treatments that have been tested are listed below:

| | Treatment | Percent kill |
|---|---|---|
| 1. | Sodium arsenite injection with Cornell tool | 64 |
| 2. | " " " with syringe | 58 |
| 3. | Arsenous acid spray | 30 |
| 4. | Kerosene oil spray (July) | 22 |
| 5. | Diesel oil spray (July) | 82 |
| 6. | 2,4-D in kerosene, 3,000 p.p.m. | 5 |
| 7. | " " 6,000 " | 74 |
| 8. | " " 12,000 " | 62 |
| 9. | Dow Gen. 1.5% in kerosene (Apr.-Oct.) | 95 |
| 10. | 2,4-D in water, 10,000 p.p.m. | 24 |
| 11. | " diesel oil, 3,000 p.p.m. | 42 |
| 12. | 2,4,5-T, 12,000 p.p.m. in diesel oil applied to individual plants | 95 |
| 13. | Ditto, applied on area basis at rate of 40 gal./A. | 12 |
| 14. | Cut with ax (Sept.) | 50 |
| 15. | Broadcast burn (June) | 43 |
| 16. | TCA 1/2 lb./gal. water (July) | 100 |

As you see, the plant kill in these tests ranged from a low of 5 percent to a high of 100 percent. The first 3 treatments employed arsenic compounds as the killing agent and were some of our first tests. Because of the hazards of arsenic poisoning to livestock and workers, we do not recommend them. Tests 4 and 5 indicate that diesel oil is more toxic than kerosene. In tests 6 to 8, 2,4-D was used in kerosene as a spray. The low (3,000 p.p.m.) concentration proved inadequate but the 12,000 p.p.m. concentration showed no advantage over 6,000 p.p.m. Dow General (DNOSBP), treatment 9, proved a good fortifier for kerosene but is somewhat expensive, and since it is toxic to humans it is objectionable to handle. Water solutions of 2,4-D were relatively ineffective, but oil-water emulsions show some promise. The 2,4-D in diesel oil at 3,000 p.p.m. gave only a 42 percent kill, but 12,000 p.p.m. of 2,4,5-T ester gave a 95 percent kill when applied as a completely covering spray to individual plants. The same solution applied on an area basis at the rate of 40 gallons per acre killed only 12 percent of the cholla. Merely cutting cholla down killed 50 percent. However, the cut plants are often replaced by a cluster of young plants whereas the joints from sprayed plants are much less likely to root.

Of all the methods tested, TCA applied in water at a concentration of 1/2 pound per gallon in July appeared best. The use of an ester form of 2,4,5-T in diesel oil at 10,000 to 12,000 p.p.m. concentration was almost as good. Both treatments were applied as a completely covering spray to individual plants during the warm part of the year. If applied at the rate of 40 gallons per acre, TCA and 2,4,5-T-in-oil would cost about $10 and $15 per acre, respectively. If figured on a per plant basis, TCA costs about 2-1/2 cents per plant, and 2,4,5-T-in-oil about 4 cents. These methods are not cheap but they can pay their way if used for controlling scattered stands of cholla during early stages of invasion.

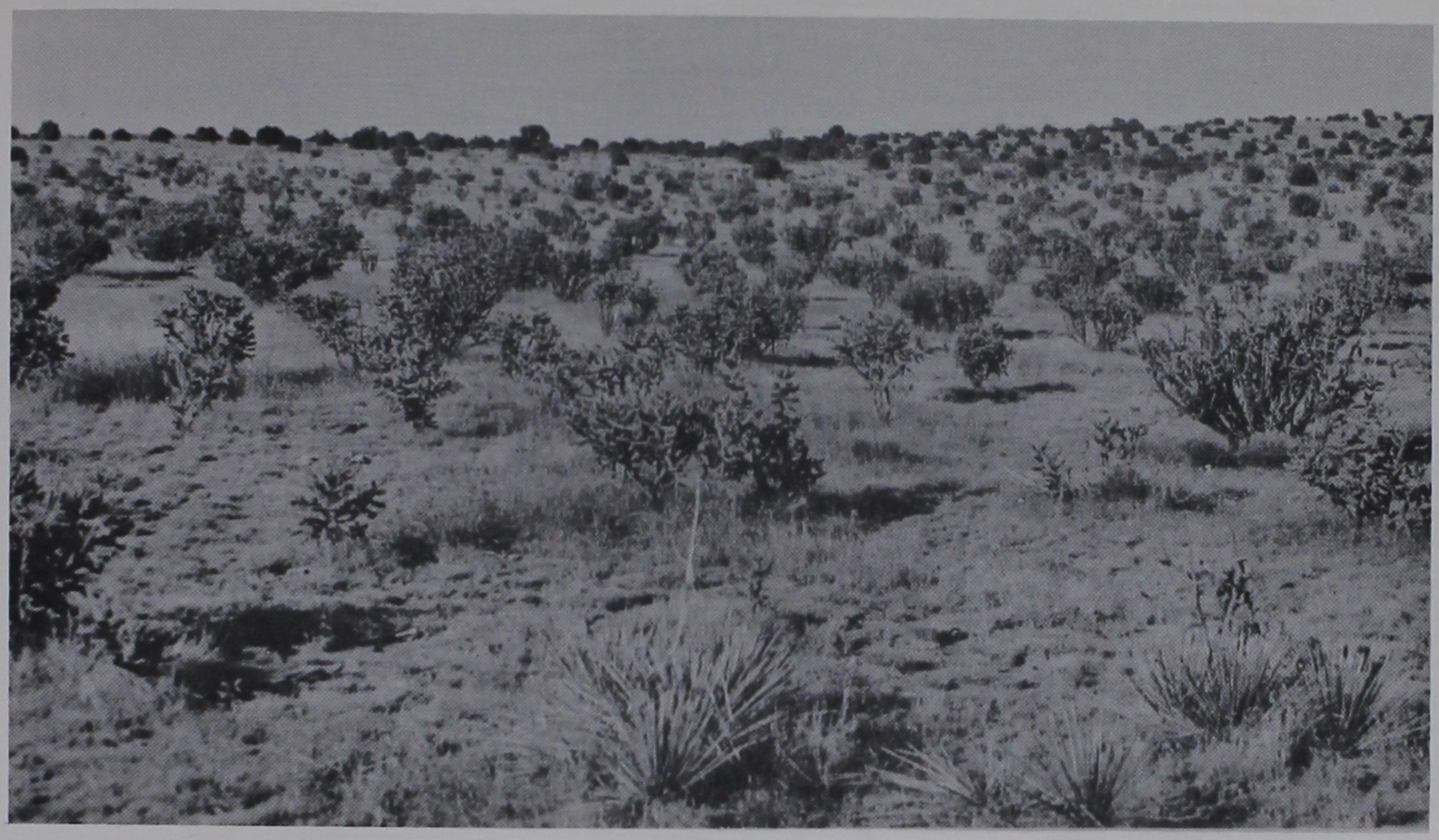

Figure 1.--Stand of cholla cacti (Opuntia arborescens) in northeastern New Mexico in 1950. This cholla is reported to be spreading in many parts of New Mexico.

Figure 3.--A stand of cholla near Oracle Junction, Arizona, almost completely killed by natural enemies.

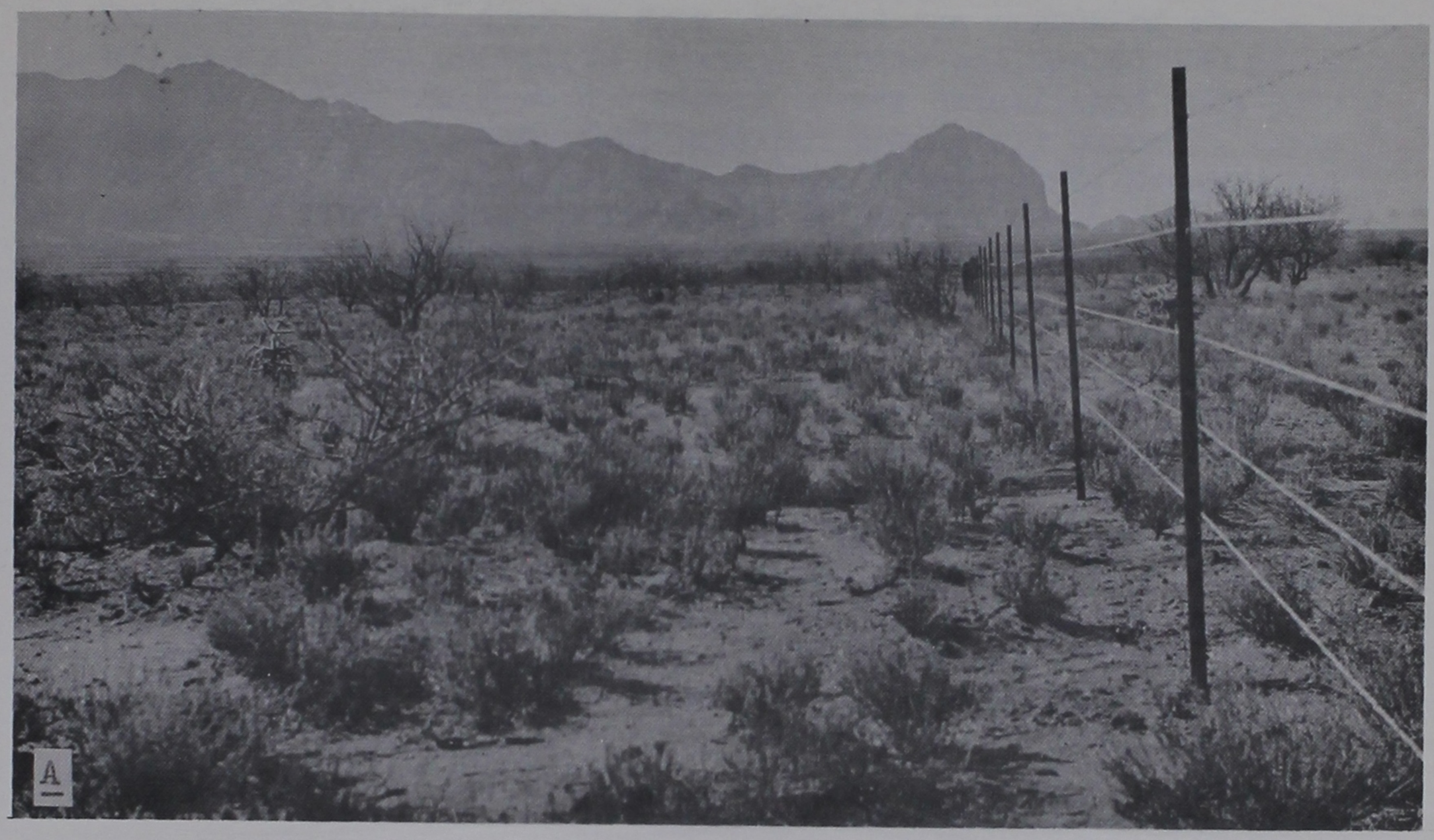

Figure 2.--Cholla can take over a range in short order. (A) This photograph taken on the Santa Rita Experimental Range in 1934 shows only two cactus plants, one to the left of center and the other near the right margin on the opposite side of the fence. (B) Only 13 years later in 1947 a dense stand of vigorous cholla plants occupied both sides of the fence.

Broadcast burning was the only large-scale method tested. Burning, which was done in June, reduced the number of cholla by 42 percent. The mortality of small cholla approached 100 percent, but soon after the fire new plants became established from joints dropped by large plants that were not completely burned. These new plants, which were included in the final count, brought the number of live plants up to within 24 percent of the original number. Also, burning has been found to affect adversely some of the valuable grasses--particularly black grama.

Cholla is not deeply rooted and is easy to push over or pull up by mechanical methods. If it were not for the new plants that become established from the old stem joints, mechanical control of cholla would be very effective. Some early work in Arizona indicates that cactus roots grow only when the soil temperature is moderately high and moisture is available. Actual tests on the Santa Rita also indicate that cholla joints root less readily in winter than in summer. So there is a chance that mechanical control may be fairly effective if done at the right time and under the right conditions.

## Summary

1. Cholla cactus is a problem wherever it occurs on rangelands. It can spread fast and will grow in many areas in the Southwest. It interferes with utilization of forage plants and competes with them for moisture and soil nutrients. In dense stands it makes livestock handling difficult. It is particularly objectionable on sheep ranges because it reduces the value of the wool.

2. Chemical control methods that are effective and economical for large areas of dense cholla have not yet been developed. Of methods tested so far, those that are economical are ineffective and those that are effective are fairly expensive. However, the best of these methods can be useful in stopping cholla invasions.

3. Mechanical control by cabling, chaining, or some similar method may have a place if it can be done at a time of year when the sprouting potential of cholla joints is low. The cooler months now appear best. More research will have to precede recommendations on this.

4. Burning on semidesert range kills a high percentage of the small cholla but some of the big plants escape. Also these surviving large plants drop a lot of joints that, in turn, take root and make new plants. So burning does not provide a complete answer yet.

5. Natural enemies, insects, disease, and fungi, or some combination often kill out small patches of cholla in southern Arizona. With more research perhaps we can enlist a few allies in our fight against cholla.

6. Since we don't yet have the tools to eradicate extensive dense cholla stands, our plea here is for you ranchers who have only 1 or 100 or a few thousand plants on your range to go home and get busy. Here's how:

(a) Mix TCA with water at the rate of 1/2 pound per gallon and spray plants until they are thoroughly wet, and dripping a little. Do the work during the warm season. Or,

(b) Mix 50 gallons of diesel oil and 1 gallon 2,4,5-T ester containing 4 pounds 2,4,5-T acid per gallon. Spray plants until completely covered. The best time to spray is during the frostfree season. Winter results have been disappointing.

A gallon of solution will cover about 20 cholla plants 2 to 4 feet tall.

7. Remember the best time to get on top of your cholla problem is when that first plant appears. Sheep and cattle plant all kinds of seed, so be careful about bringing in sheep or cattle from cactus-infested ranges if your range is clean.

# REPRODUCTION AND LIFE SPAN OF SOME SOUTHWESTERN RANGE GRASSES

Elbert H. Reid[1/]

Establishment of seedlings and the life span of several southwestern grasses were studied by R. H. Canfield, formerly range conservationist, Rocky Mountain Forest and Range Experiment Station. Mr. Canfield traced about 48,000 individual grass plants on chartograph records taken over a 17-year period to determine how many seedlings were produced, how many survived the first year, and of the seedlings that did survive, how long they lived. These studies are the basis for this paper.

Perennial grasses studied were: black grama (Bouteloua eriopoda), hairy grama (B. hirsuta), sideoats grama (B. curtipendula), Arizona cottongrass (Trichachne californica), mesa threeawn (Aristida hamulosa), tanglehead (Heteropogon contortus), Texas timothy (Lycurus phleoides), Rothrock grama (B. rothrocki), slender grama (B. filiformis), sprucetop grama (B. chondrosioides), and curlymesquite (Hilaria belangeri). The studies were conducted on the Santa Rita Experimental Range south of Tucson, Arizona.

Each species did not grow on every plot, and interaction between species was not segregated. However, the analysis gives some new information on seedling production and length of life of several species on the area studied.

Plants were studied under two general conditions: (1) year-long grazing and (2) no grazing. The grazed plots were subject to wide differences in utilization because they varied as to distance from water, slope, accessibility, and other factors. On the average, however, the entire range was utilized to slightly less than half the perennial grass herbage.

## Seedling Production and Survival

All grasses produced some seedlings each year. For most species, these were from seed, but in the case of black grama some were by new sets from the old plants. The number of seedlings varied greatly by species. Number of seedlings also differed for grazed plots and ungrazed plots.

As shown in table 1, Rothrock grama and curlymesquite produced the most seedlings, followed by sprucetop and slender gramas. Arizona cottongrass produced the fewest seedlings.

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1/Chief, Division of Range Management Research, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

Table 1.-- Average seedling production of some perennial grasses on the Santa Rita Experimental Range, Arizona

| Species | Annual number of new plants per square meter plot (17-year average) | |
|---|---|---|
| | Grazed | Ungrazed |
| | No. | No. |
| **Primary grasses** | | |
| Tanglehead | 2.3 | 6.9 |
| Black grama | 2.8 | 6.4 |
| Sideoats grama | 3.9 | 5.0 |
| Texas timothy | 6.2 | 3.1 |
| Hairy grama | 2.9 | 3.1 |
| Mesa threeawn | 2.6 | 2.4 |
| Arizona cottongrass | 0.9 | 0.5 |
| **Secondary grasses** | | |
| Rothrock grama | 29.0 | 15.7 |
| Curlymesquite | 23.6 | 11.2 |
| Sprucetop grama | 12.6 | 7.8 |
| Slender grama | 11.9 | 5.2 |

Of the grasses studied, black, sideoats, and hairy gramas, tanglehead, Texas timothy, mesa threeawn, and Arizona cottongrass (hereinafter called primary grasses) are species that tend to predominate on ranges in good condition. Three of these grasses, black and sideoats gramas and tanglehead, produced more seedlings on ungrazed areas than on grazed areas. The greatest difference was found with tanglehead, which produced an average of 6.9 seedlings per year per square meter on the ungrazed area compared with 2.3 seedlings per year per square meter on the grazed area. The number of seedlings produced by hairy grama, mesa threeawn, and Arizona cottongrass was about the same on ungrazed areas as on grazed areas. Texas timothy produced more seedlings on the grazed area.

Grasses that usually are more abundant on ranges with a history of heavy grazing use than on well managed ranges or protected areas--Rothrock, sprucetop, and slender gramas, and curlymesquite (hereinafter called secondary grasses)-- all produced more seedlings on the grazed areas than on the ungrazed areas. Also, more seedlings were produced by this group of grasses than by the primary grasses, particularly on the grazed plots.

Seedling survival during their first year varied with species, ranging from 10 percent to 65 percent.

The primary grasses, with the exception of sideoats grama, had greater survival on the ungrazed range than on the grazed range. All grasses but tanglehead had fairly good seedling survival, considering the climatic stresses under which the plants grew.

Of the secondary grasses, curlymesquite and slender grama seedlings survived better on grazed range than on ungrazed range; those of Rothrock grama survived about the same under both conditions; and those of sprucetop grama survived better on ungrazed range.

On the average, percentage seedling survival of secondary grasses was about the same as for the primary grasses. However, because the secondary grasses produced more seedlings on the average, a greater actual number of seedlings usually survived.

## Longevity of Established Plants

In general, all the species studied appeared to be relatively short lived. Black grama, sprucetop grama, Arizona cottongrass, and mesa threeawn were the longest lived, with some black grama plants living 14 years. Rothrock grama was the shortest lived. No plants of Rothrock grama lived more than 3 years where protected, or more than 4 years where grazed.

There was considerable variation in the life span of individual species. Differences also were found between the grazed and the ungrazed ranges. Primary grasses tended to live much longer on ungrazed range than on grazed range, whereas secondary grasses tended to live longer on grazed range than on ungrazed range. This is illustrated in figures 1 and 2, where black grama and hairy grama are shown as examples of the primary grasses and curlymesquite and slender grama as examples of the secondary grasses.

Both hairy grama and black grama lived much longer on ungrazed range than on grazed range. On the other hand, curlymesquite and slender grama lived longer on the grazed range. With the exception of sideoats grama, all the primary grasses lived longer under protection than under grazing. Sideoats grama and the secondary grasses tended to live longer where grazed than where protected.

## Summary and Conclusions

The study shows that yearlong grazing tended to decrease both the number of seedlings produced by the better range grasses and their initial survival. Also, grazing tended to increase both the number of seedlings produced by the less desirable grasses and their initial survival. Despite these effects, however, seedlings of all species studied were produced each year under all conditions and usually in sufficient numbers to maintain range conditions.

Also, grazing tends to cause greater mortality in some of the better species, not only of the seedlings but also of older plants. On the other hand, the less desirable species tended to survive better where grazing occurred than where it was excluded.

The problem of range maintenance and improvement under the conditions of the study was not one of producing seedlings of the better plants, but rather to graze the range in a manner that would encourage their establishment and growth.

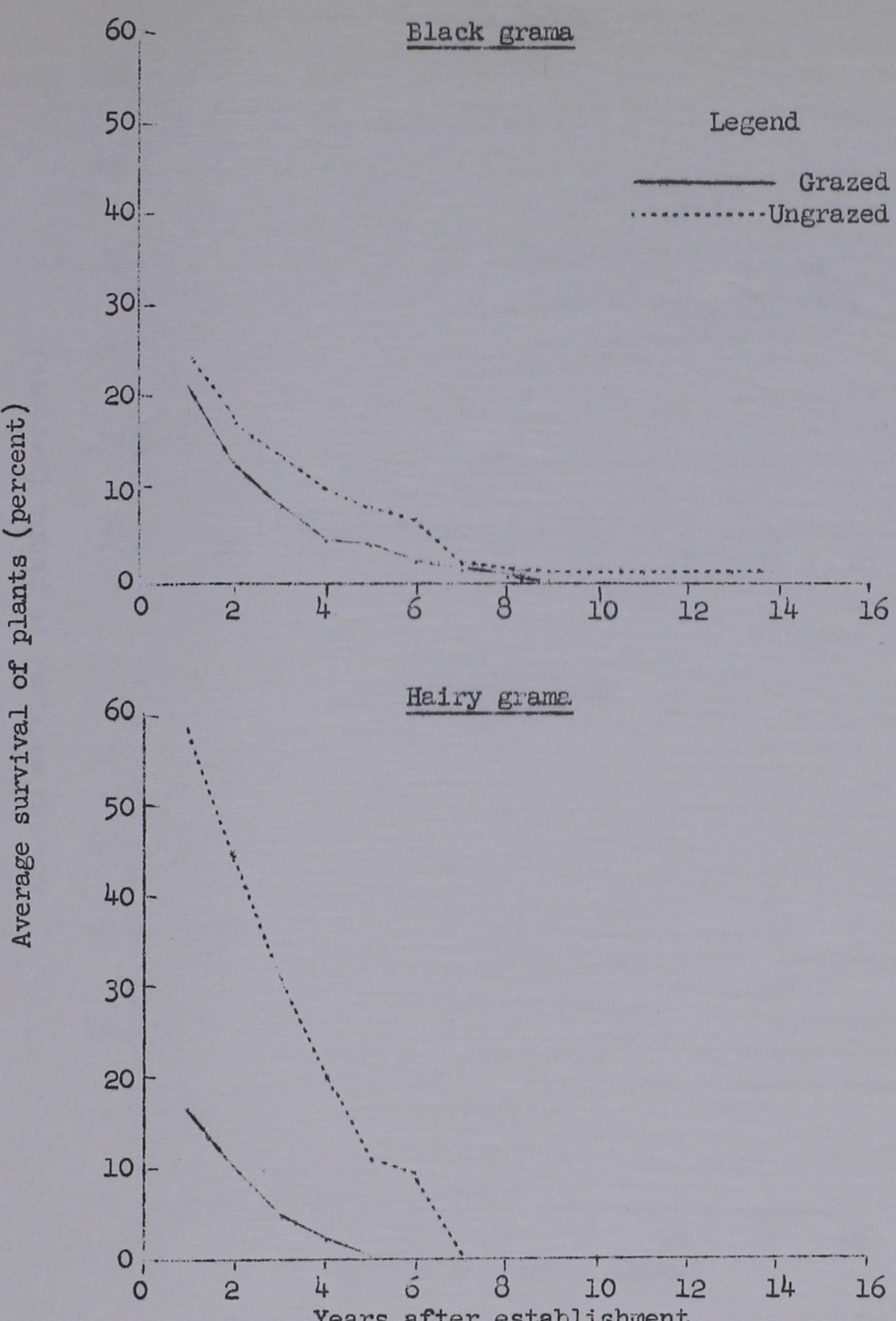


Figure 1.-- Survival of black and hairy gramas on grazed and ungrazed plots.

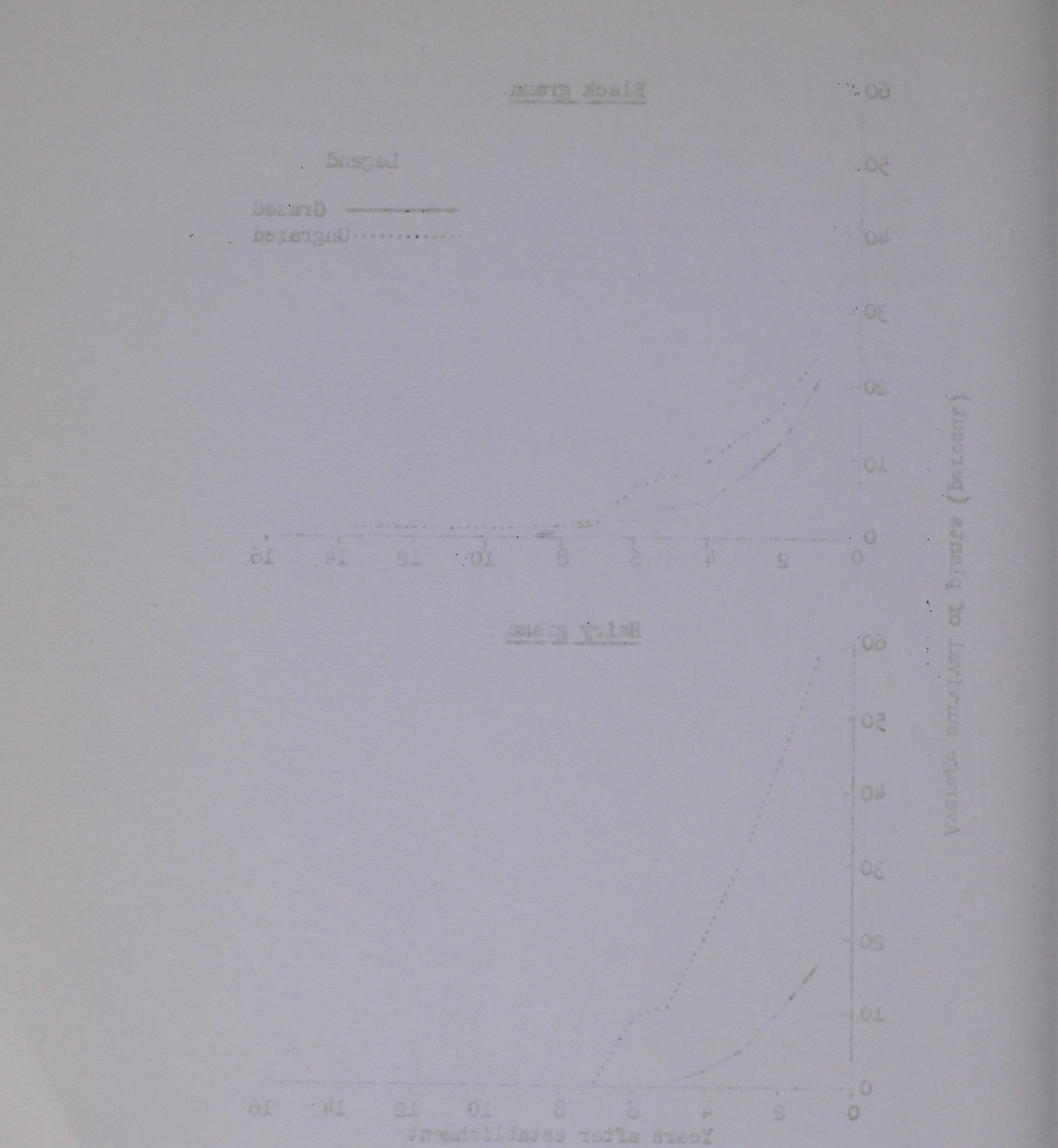


Figure 1.-- Survival of black and hairy grasses on grazed and ungrazed plots.

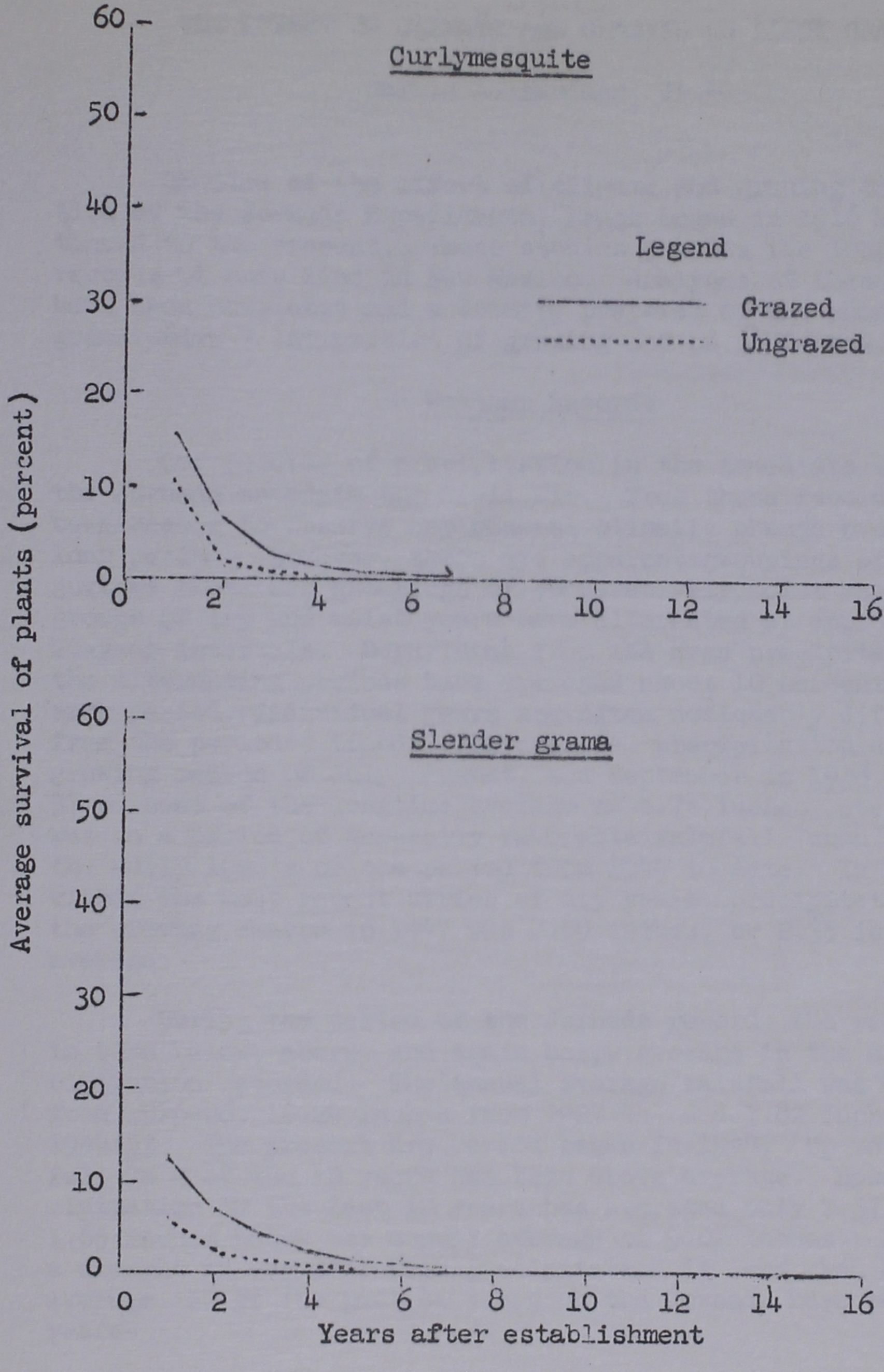


Figure 2.-- Survival of curlymesquite and slender grama on grazed and ungrazed plots.

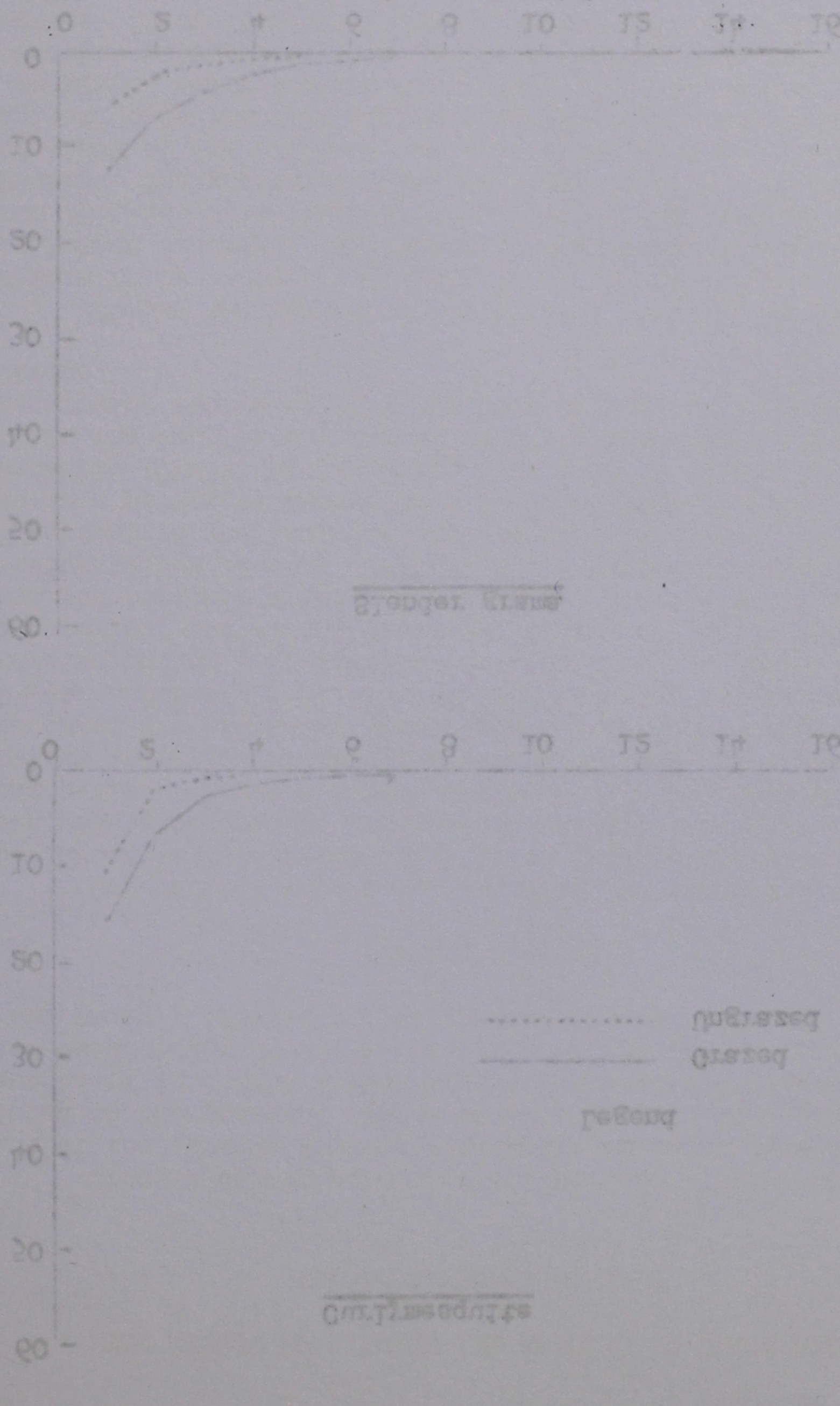


Figure 5.--- Survival of control and irradiated bacteria.

# THE EFFECT OF CLIMATE AND GRAZING ON BLACK GRAMA

Harold A. Paulsen, Jr.[1/]

Studies of the effect of climate and grazing on the vegetation of the Jornada Experimental Range began in 1916 and have continued to the present. These studies provide the longest continuous records of this kind in New Mexico. Analyses of these records have been completed and a summary prepared of the changes in black grama under 3 intensities of grazing and on protected plots.

## Weather Records

Our records of precipitation in the immediate vicinity of the Jornada antedate the Civil War. From these records we have been unable to observe any general climatic change over this long period. However, there are apparent groupings of dry years just as there are groupings of comparatively moist years. These groups of dry and moist years have alternated at approximately 20-year intervals. Departures from the mean precipitation in the alternating periods have averaged about 10 percent. Within each period, individual years are often noticeably different from the periodic trend. For example, precipitation during the growing season of July, August, and September in 1935 was only 37 percent of the longtime average of 4.74 inches, even though this was in a period of generally favorable rainfall when compared with the early 1920's or the period from 1944 to date. In contrast, within the most recent series of dry years, precipitation during the growing season in 1947 was 7.09 inches, or 2.35 inches above average.

During the period of the Jornada record, the years have been in turn below, above, and again below average in the amount of precipitation recorded. The annual average rainfall was 8.02 inches from 1916-26, 10.24 inches from 1927-44, and 7.82 inches from 1944-53. The present dry period began in 1944. Up to 1956, rainfall in 2 of the 12 years has been above average. However, precipitation in the last 12 years has averaged only 7.37 inches, or 1.65 inches below the annual average of 9.02 inches. If we define a drought as any year when precipitation is less than 85 percent of average, 12 of the past 40 years on the Jornada have been drought years.

## Effects of Drought

Black grama basal area or density fluctuates with the precipitation on the Jornada. Records of changes in the perennial grasses have been obtained by charting the area of the perennial

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1/ Range Conservationist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

grass cover at the ground level upon meter square quadrats each year. Although records are available from several major plant types and species of the Jornada, this discussion will be limited to black grama. Figure 1 shows the average density of black grama on quadrats protected from livestock grazing from 1916-53. The precipitation pattern of the Jornada is also shown. The cumulative deviations from the mean are plotted to illustrate rainfall cycles. Thus, as rainfall is less than average, the trend line is downward and, conversely, as rainfall is greater than average the trend is up.

The black grama plants on the ungrazed quadrats averaged 424 square centimeters in basal area, or about 4-1/4 percent of the quadrat surface area. Average maximum black grama density of these quadrats was 9-1/2 percent of the total area; but in 1 year, black grama occupied nearly 16 percent of the surface area of one quadrat. The maximum and minimum black grama densities in relation to the area of the quadrat are shown in figure 2. Even in the favorable rainfall period, the maximum root-crown area of black grama occupied only a small percentage of the total ground surface. However, much more area is directly protected from wind and rain by the leaves and stems of the plants. The crown spread of the plants greatly exceedsthe basal area and often appears to completely cover the ground surface.

During the drought period of 1916-27, the density of quadrats protected from grazing declined to only 0.3 of 1 percent of the quadrat area. In a single year, drought reduced black grama by 90 percent. Rainfall during the growing season in this period was below the 4.74-inch average, although in 3 out of 11 years rainfall was above this average. In 2 years of above-average precipitation (1920 and 1921), the vegetation recovered to nearly its original density. In 1922, however, rainfall was only 3.49 inches and black grama density declined the following year.

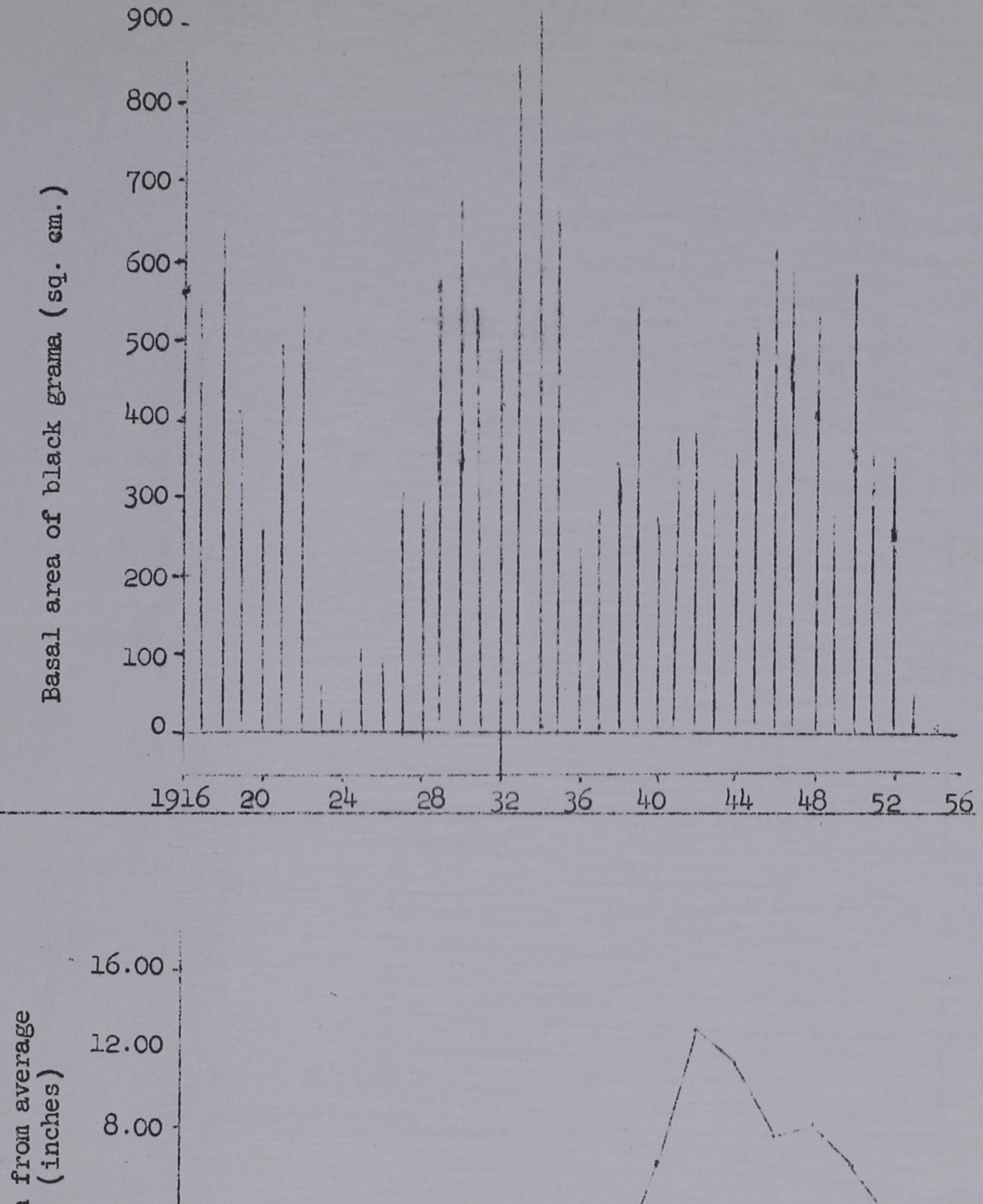
The effect of more favorable rainfall in 1927 was evident in 1928. With more abundant rainfall, black grama increased until it reached its highest point, averaging 9-1/2 percent of the quadrat area in 1934. Rainfall in the growing season in 1935 was only 37 percent of average and density declined during the next 2 years. Through the remainder of the moist period, the density of the protected quadrats averaged about 4.4 percent, somewhat lower than in the 1927-34 period. In part, this was a result of several years of precipitation, which, although adequate in amount, was ill-timed and not wholly effective for plant growth.

Since 1943, rainfall during the growing season has averaged 3.71 inches. Moreover, in 5 out of the 13 years, it has averaged only 1.73 inches.

## Effects of Grazing

Similar records are available on quadrats grazed by cattle over the same period. Records are for 30 quadrats that can be grouped by 3 degrees of grazing. One group was conservatively grazed,

Figure 1.-- Changes of black grama density on protected quadrats and annual precipitation as determined by cumulative deviations from the mean.



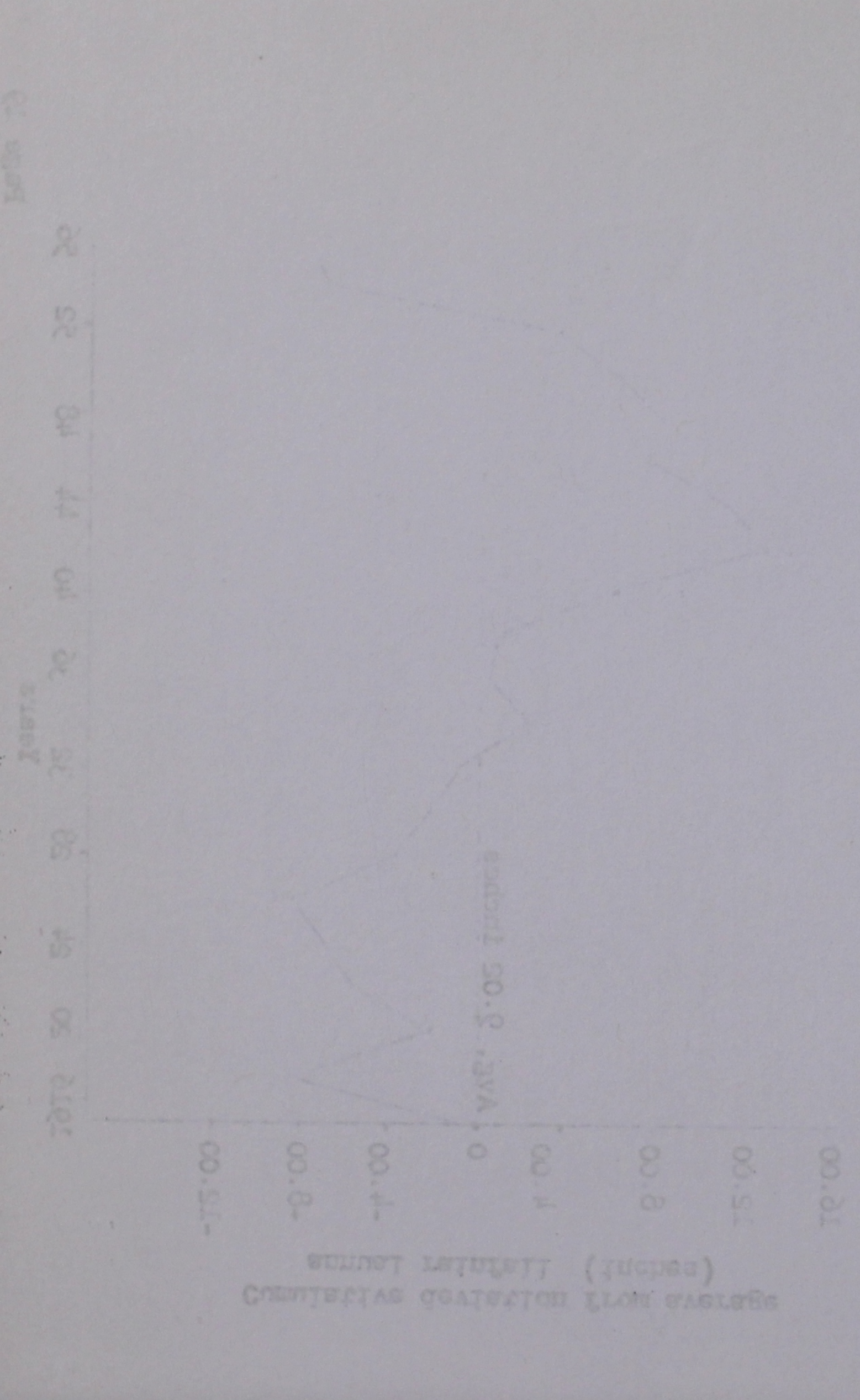



Fig. 1.—Cumulative departures from average annual rainfall at Kansas City, Missouri, 1900–1950.

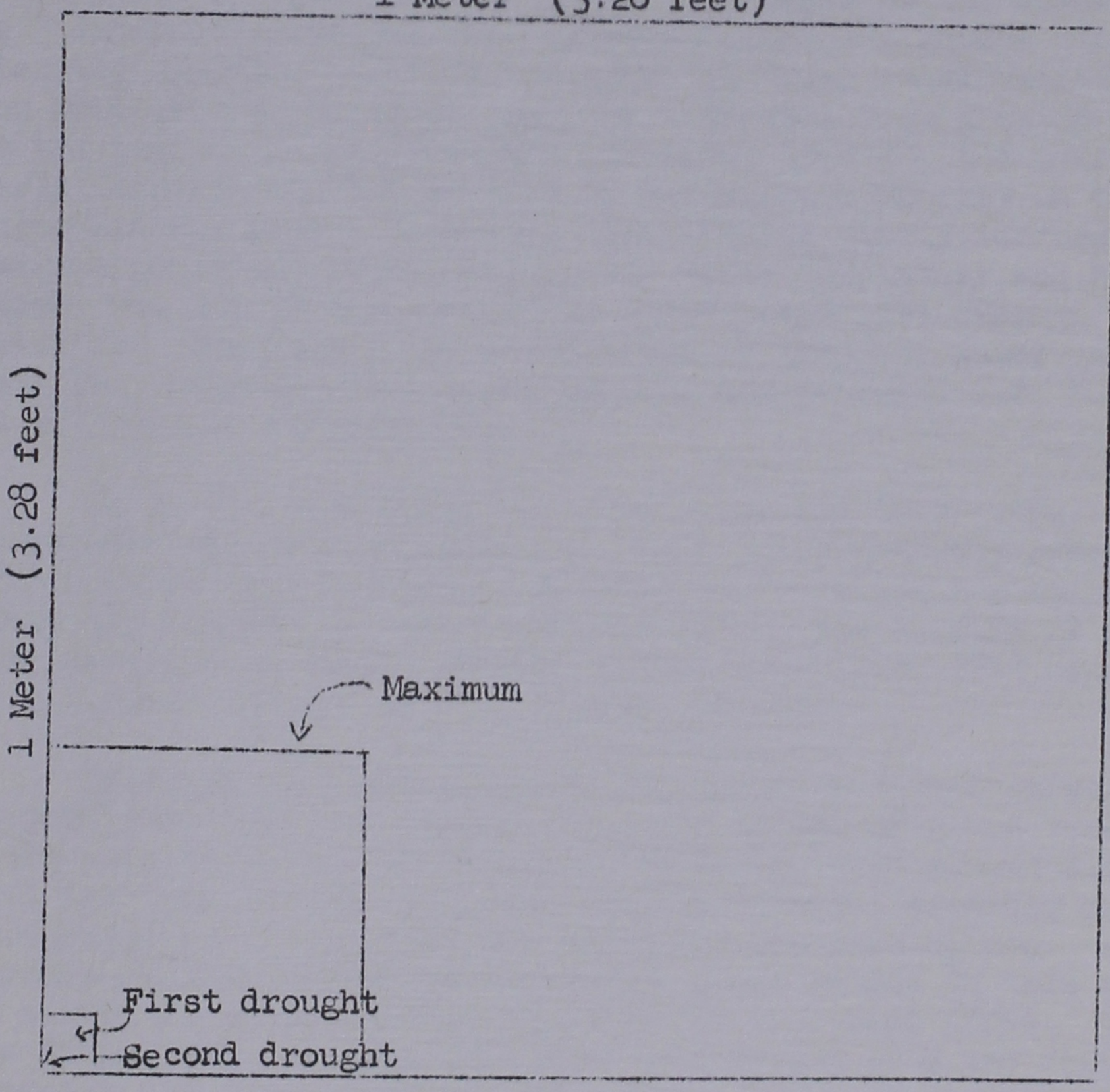



Figure 2.-- Comparison of the surface area of meter square quadrats with the extremes of black grama density under protection from grazing.

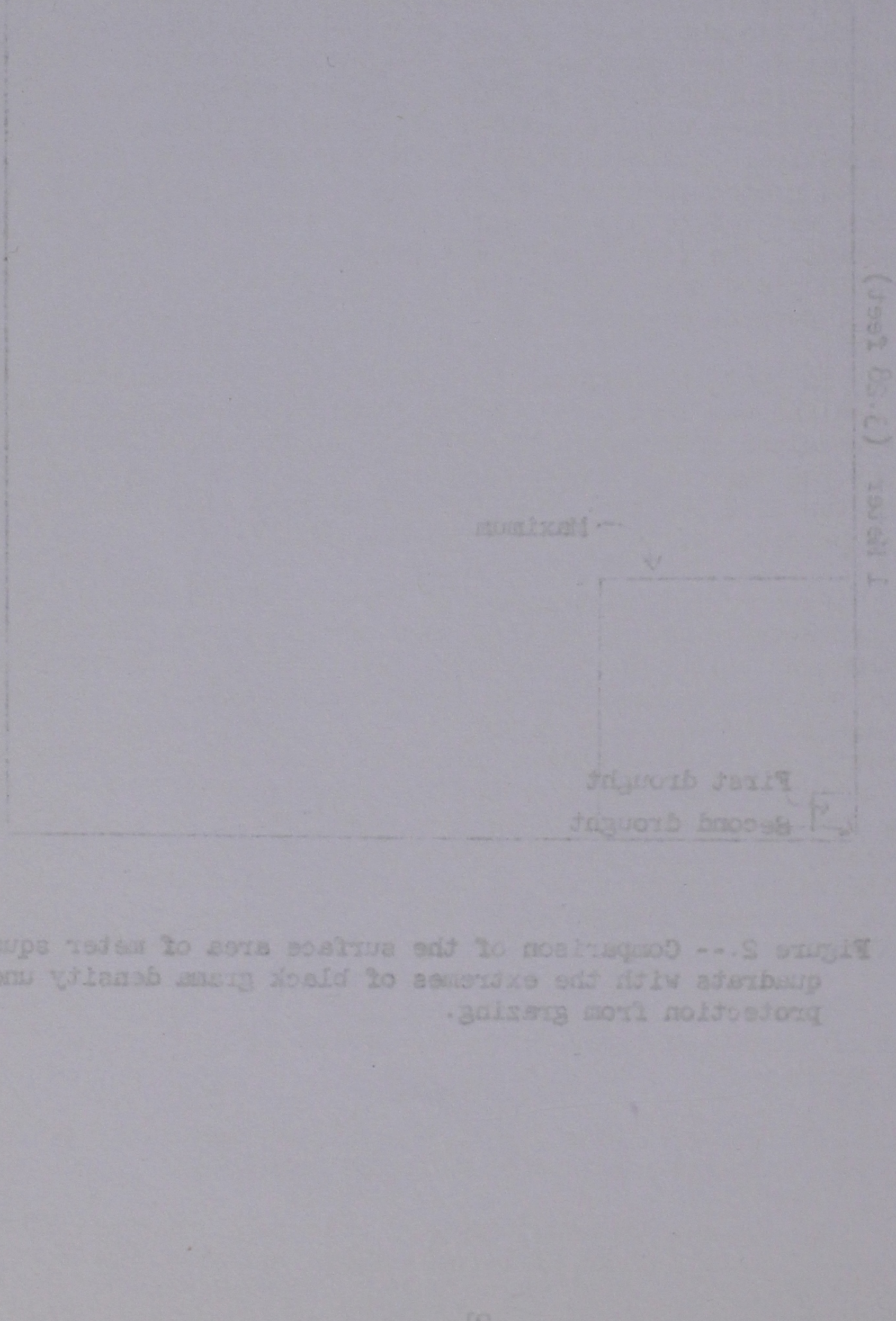



Figure 2.-- Comparison of the surface area of water square
protection from grazing.

usually having less than 40 percent of the current year's herbage grazed. Another was moderately grazed, with 40-55 percent herbage removal. The third group was heavily grazed, with over 55 percent removal. Changes in black grama under these grazing intensities are illustrated in figure 3.

The average density of black grama on the grazed quadrats from 1916-53 varied inversely with the degree of grazing use. Drought, however, reduced the density of black grama to about the same point, irrespective of the intensity of use. For example, in the first drought period, 1916-27, averages of the quadrats in the 3 intensities of use were between 83 and 127 square centimeters. After the drought, recovery was greatest under conservative use--even greater than on those quadrats protected from grazing. During the period of more abundant moisture, 1927-43, the average yearly increase was 6.6 percent of the average density on the conservatively grazed quadrats. The average yearly increase on quadrats protected from grazing, and those moderately and heavily grazed, was 1.2 to 3.3 percent of their respective average densities. The density of black grama on quadrats under conservative, moderate, and heavy grazing use averaged 7.6, 5.2, and 4.7 percent respectively.

In 1943, black grama declined under all conditions, although the decline was most prominent on those conservatively grazed. This resulted from the higher density in the preceding moist period. Before the current drought became critical, the density of black grama was 12.2 percent. Average annual loss since 1943 has amounted to 13 percent of the average quadrat density.

Recovery of black grama on the grazed quadrats as well as on the protected quadrats depends upon the amount of grama remaining at the conclusion of the drought. If it had been almost eliminated, as it has been already in places on the Jornada, recovery must necessarily be slow, no matter how light the grazing use. In the recovery of drought-reduced perennial grass stands in this area, the number of seedling dropseeds usually increases first. These come from seeds stored in the soil that sprout with the first favorable rainfall. Unlike black grama, dropseed reproduces prolifically from seed and often provides considerable cover, which is of some forage value, until black grama can become re-established.

Several points warrant reemphasis in a summary of the effect of climate and grazing on the stands of black grama of southern New Mexico:

1. The precipitation of the Jornada area shows no general longtime upward or downward trend.

2. At approximately 20-year intervals, rainfall is alternately about 10 percent above and below average.

3. Irrespective of the degree of grazing use, black grama quadrat density is reduced to about the same point during extended droughts.

4. Black grama density, during years of more abundant rainfall, is greatest on areas conservatively grazed.

5. Rate of recovery after drought depends on the stand that remains to revegetate the area at the end of the drought.

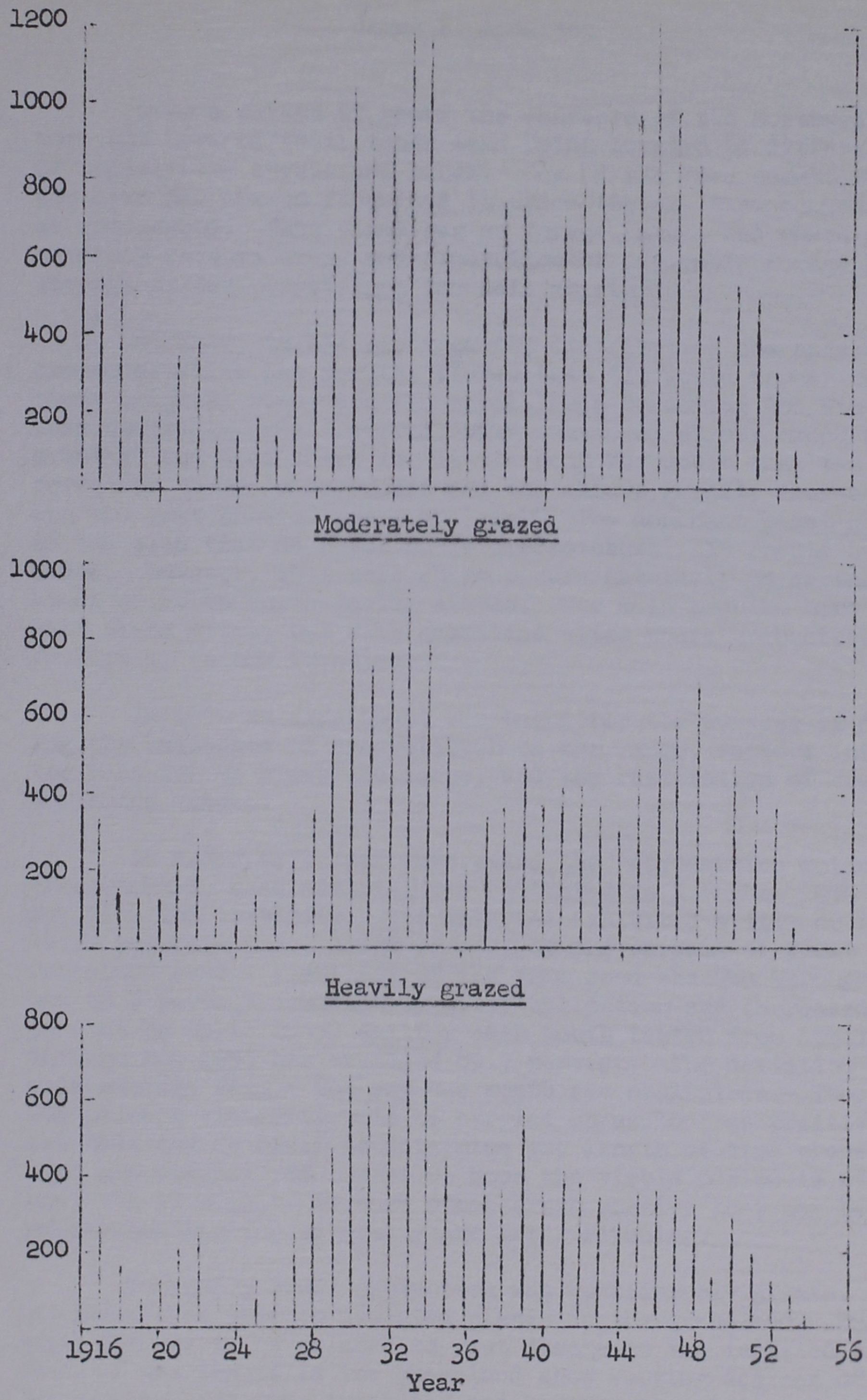
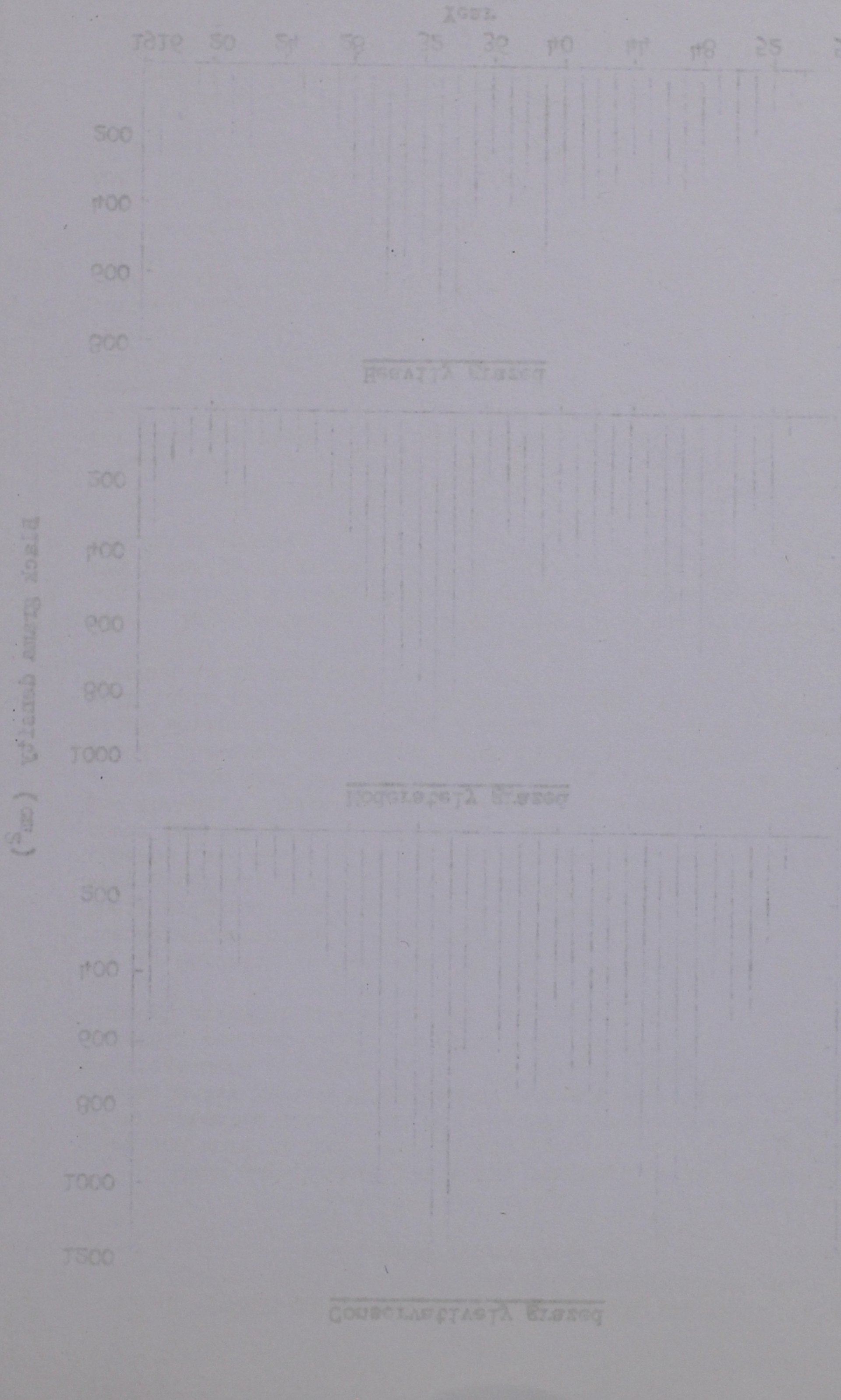



Figure 3.-- Black grama density on quadrats exposed to three intensities of grazing.

Figure 3.-- Black flame speed as a function of equivalence ratio for three intensities of turbulence.



# THE CREOSOTEBUSH PROBLEM IN NEW MEXICO

James E. Anderson

Over a period of years the ranchers of the Southwest have seen more and more of their range land being invaded by different kinds of undesirable shrubs and brush. One of the more common invaders of southern New Mexico rangeland is creosotebush, also commonly known as greasewood. This plant has no forage value, and where prominent, severely reduces stand and production of desirable forage plants through strong competition for soil moisture.

Gardner, in his study of the distribution and spread of creosotebush in New Mexico, stated that "It would appear that in their original condition the table-lands bordering the Rio Grande were generally grass-covered, with scattered shrubs among the grasses" and that there is "little room for doubt that the grass cover has markedly decreased and the shrubs greatly increased during the past hundred years or less." The dominant plant over much of the area that he observed is creosotebush. It should be understood, however, that this shrub occurs naturally on certain shallow stony soils on south-facing slopes. Our main problem here is not with these sites, but with grassland sites where creosotebush has invaded or is now invading.

In 1954 an experiment was begun for the purpose of determining the influence of creosotebush on the range, factors influencing its invasion of grassland range, and the restoration of creosotebush-dominated ranges.

In order to better understand the reproduction potential of creosotebush, seed material was collected in November 1954 and tested for fill and viability. The material exhibited a fill or set of 44.28 percent--i.e., 44.28 percent of the carpels or fruit segments contained seed. Viability of the same seed checked through May 1956 was 63.8 percent immediately after collection and increased to 96.3 percent by April 1955, and for each month tested from April 1955 through May 1956 has averaged 89.7 percent. The deviation from this average figure for any one month was negligible. These tests for percent viability will be carried on as long as positive results are obtained in order to determine the length of time creosotebush seed are viable. Of course we hope the viable period is a short one, but if similar to some other brush species they may be capable of germinating for several years after ripening.

Generally fruit production was considerably greater in creosotebush type than on isolated plants in the grassland. This difference appears to be related to past damage to the isolated plants. Most of the plants in the grassland show varying degrees of damage by rabbits, and some trampling and horning by cattle. Plants in the creosotebush type show little if any damage from rabbits and livestock. Field samples of fruit production from plants in the

creosotebush type and in the grassland type produced 150.7 and 44.1 fruit per square foot respectively. This is a significant factor influencing the rate of invasion as may be seen by comparing establishment adjacent to the creosotebush type and establishment from isolated plants in the grassland type. Thus it may be said that rabbits do exert some measure of control as their pruning of the plant does tend to reduce fruit production.

Soils from six sites were used to check response of creosotebush to various soils. The soils used were:

| | |
|---|---|
| Rocky silt loam -- | from old creosotebush type |
| Shallow sandy loam -- | from recent creosotebush type |
| Deep sandy loam -- | from deteriorated grassland |
| Stony silt loam -- | from eroded, deteriorated grassland |
| Stable sandy loam -- | from good black grama grassland |
| Stable heavy clay loam -- | from good tobosa grass swale |

Pot tests revealed that creosotebush is about equally adapted to the various soils tested. This would indicate that site differences due to these soils are probably not a limiting factor to the spread of creosotebush, and that many areas in southern New Mexico are subject to still further invasion of this undesirable shrub.

Spot seeding test in the field to determine emergence and survival under natural conditions resulted in a very low rate of establishment during the 1955 season. Only 1.55 percent of seed planted at four different sites produced seedlings surviving at the end of the growing season, and only 18 percent of the 1.55 percent were alive this past summer. Losses were attributed to rodent damage, cattle trampling, damping off, and to the abnormally dry conditions prevailing at the seeding sites. No seedlings appeared from the 1956 planting due to extreme drought conditions. From June 15, 1956, the date of planting, through September 15, 1956, the average rainfall for the planting sites was only 2.18 inches, and for the 10 months preceding this period virtually no effective rainfall occurred.

In the summer of 1955 field plots were established on ranches near Tularosa, Truth or Consequences, Deming, and Rincon, New Mexico, for the purpose of determining the influence of grazing by domestic livestock and rodents and rabbits, and competition by creosotebush on restoration of desirable range grasses. Results to date are inconclusive, primarily for two reasons: drought conditions and the short span of time the plots have been established. However, several significant observations were made at the four different locations. In and adjacent to the plots remnant stands composed of from one to several species of desirable grasses were found, indicating that in the past these sites have produced considerable amounts of forage as compared to their present production.

Desirable forage grasses found on the four different sites are listed below:

Tularosa: Alkali sacaton
Truth or Consequences: Cane beardgrass, vine mesquite, Hall's panicum, blue grama, black grama, sideoats grama, bush muhly, tobosa grass, spike dropseed, alkali sacaton, and threeawn species
Deming: Cane beardgrass, vine mesquite, blue grama, black grama, sideoats grama, bush muhly, and tobosa grass
Rincon: Black grama and tobosa grass

Although some soil loss was observed at each location, it is believed that by reducing or eradicating the stand of creosotebush on such sites and by use of sound range management practices that these sites may again produce forage in amounts approaching that of the past.

Plots were also established on the College Ranch to measure the rate of natural invasion of creosotebush in open grassland. Mature, isolated parent plants were selected and the area around these checked for seedlings or the progeny of the older plant. One young creosotebush plant per plot was found on 75 percent of the plots and none on 25 percent. Each plot was 2.88 acres in area. Observations made in close proximity to mature stands of creosotebush show that as many as 30 young plants per thousandth acre may be found. Thus the rate of reproduction and invasion is much greater adjacent to the creosotebush type than it is in areas of isolated plants.

To date little work has been done on control measures and the only sure method that we can now recommend is grubbing. In grassland areas where there are only a small number of plants per acre, or where creosotebush is moving out onto grassland from sites dominated by the plant, it appears quite feasible for the rancher to use this means of control. When grubbing, one should be certain to grub the plant below the crown as sprouting will likely occur if the tops only are cut off.

The present results of this study

Without careful consideration the results of this study may be somewhat misleading; that is, one might conclude that creosotebush is not really a problem of concern to the rancher. True, it does appear to be a slow invader, but its progress is positive, and as Gardner has pointed out, there is little doubt that much of our grassland has already been replaced by creosotebush and there is no reason to believe that this invasion will not continue unless measures are taken to halt it.

# FORAGE CROP VARIATION AND APPRAISAL

K. A. Valentine

Stoddart and Smith,in their textbook on range management, state that annual variation in forage production on the range is one of the most complicating factors to be dealt with in range management. Most ranchers will probably agree with that statement. If each year's forage production were just the same as any other year's production, much of the complexity, uncertainty, and risk would be removed from range and livestock management. About the same number of livestock could be safely carried and production would be about the same from year to year, at least as far as forage supply determines production.

Further, and probably well known to the experienced rancher, annual forage production does not vary closely around average production, but instead varies widely around the average. It is of course this wideness in variation that is really the complicating factor. If the variation were always small, it would not constitute a problem at all; the small variations could be ignored.

Another significant feature of forage production on the range, particularly on southwestern range, is the fact that as a rule most of the growth is made in a relatively short period during the summer growing season, and this growth constitutes the main forage supply for the year. Stock must depend largely upon this production for the following 6, 8, or sometimes even 10 months or longer. In some years we do have an appreciable amount of growth in fall, late winter, or spring, but these are exceptions to the rule, and the rancher does well not to place much dependence upon this off-season growth. It is always welcome when it comes, but it does not come consistently enough to base stocking on. The significance of this short period of production of forage is that whatever the supply may turn out to be, the rancher has it on hand at the end of the growing season and can appraise it and base his fall, winter, and spring stocking on the results of his appraisal.

Several solutions have been proposed for the problem of fluctuating forage production. One type of solution involves constant stocking at relatively low levels, which minimize the impact of low forage production on the ranch operation. Other plans involve fluctuating stocking with forage production. Obviously all plans of the latter type imply some kind of yearly forage production appraisal.

It should be appreciated, of course, that the matter of forage crop appraisal is clearly associated with proper use of range forage and proper nutrition of range livestock, two all important fundamentals in range and livestock management. Unless stocking is balanced with the actual forage production, it is quite unlikely that utilization of forage yielding vegetation will be as it should be, and that grazing animals will be on full forage allowance without waste.

Some kind of forage production estimates have of course been made by range users all along, but as range and livestock become more valuable, range and livestock management practices of necessity become more highly developed in order to make more efficient use of the range and at the same time insure its maintenance. Forage crop appraisal methods have accordingly come in for their share of study and refinement. In line with this general development, we have set up an experiment to determine variation in forage production and means of appraising production. The experiment is not complete as yet, but several interesting findings have been made. In the study we have attempted to determine the relationship existing between certain factors of forage production and actual production and between several types of estimates of production and actual production.

The first of the factors of production studied is amount of growing season rainfall--that is, rainfall coming in the months of July, August, and September. It would seem to be quite reasonable to suppose that forage production might be closely correlated with amount of growing season rainfall, since rainfall is quite clearly one of the primary factors responsible for plant growth on the range. As a matter of fact, studies on desert rangeland in Utah have revealed a good correlation between rainfall and forage growth. However, our study thus far has not shown a consistent relationship between amount of rainfall and forage growth under our conditions. In fact, correlation is quite low. Analysis of data shows that only 3.38 percent of the variation in forage production is accounted for by variation in growing season rainfall. Thus amount of growing season rainfall has not been a good indicator of forage production under our conditions.

The results obtained from the rainfall and forage yield analysis were in reality not surprising, because during the course of the work it has been apparent that stand of forage yielding plants varies widely between study plots and that this variation has been responsible for much of the variation in forage yield. Analysis of stand and yield values shows a much better correlation between these values than between rainfall and yield. The analysis shows that 42.8 percent of the variation in yield is accounted for by variation in stand.

It hardly seems reasonable to dismiss rainfall as an indicator of forage production on the range when we know that all growth on the range is entirely dependent upon rainfall. It seems best to recognize that both stand of forage yielding plants and amount of growing season rainfall are important factors in determining forage yield. Accordingly both stand and rainfall values were used together in an analysis to determine their combined influence on forage yield. We used a very simple method of obtaining the combined stand and rainfall value: We simply multiplied the two values together. This implies that we would expect yield to vary directly in proportion to variations in both stand and rainfall. The analysis revealed a highly consistent relationship. The combined stand and rainfall value accounts for 65 percent of the variation in forage production.

It might appear that amount of rainfall and stand of forage yielding plants should account for practically all variation in forage production on the range; however, there are certain other factors that must influence production. One of these is distribution of rainfall through the growing season. In some years rainfall may be well distributed through the season with the result that near maximum growth is made by plants. In other years the same total amount of rain may be poorly distributed, with the result that maximum growth from that amount of rainfall is not realized. Variation in thrift or vigor of plants may also cause variation in production. Plants in poor thrift will not make the same growth that plants in good thrift will under the same rainfall. Soil at the different study sites is similar and is not thought to be responsible for variation in forage production from site to site, but there is a possibility that it is responsible for more variation than we are aware of. Certainly on rangelands exhibiting appreciable diversity of soil and topograpy, these factors would have to be considered as influencing forage yield.

The forage estimate part of the study was set up to determine the possibility of making forage crop appraisals by simple, rapid estimate methods. Four types of estimates have been included in the study: (1) Offhand estimates of production expressed as a percent of maximum production;(2) Analytical estimates of production expressed as percent of maximum production; (3) Offhand estimates of production expressed in pounds per acre; and (4) Analytical estimates of production expressed in pounds per acre. Estimates have been made by five persons.

The offhand estimate as percent of maximum obviously requires that the estimator have a mental picture of maximum production to use as a basis of comparison. Unfortunately we have not seen such a condition here for several years and our mental pictures of this condition are becoming somewhat hazy. However, with a little training on some of the better remaining stands of grass, results of these offhand estimates were surprisingly good. There is some variation among individual estimators, but all compare favorably with results of the stand and rainfall combination indicator of forage production. Attempts to improve the consistency of estimating as a percent of maximum yield analytically--that is, by first estimating percent of maximum stand and percent of maximum individual plant growth and then using the product of these estimates to estimate percent of maximum yield--failed. Using the analytical method, the estimates were generally not as consistent as the offhand estimates.

Offhand estimates of yield in pounds per acre were generally less consistent with actual yield than estimates as percent of maximum yield. The lower consistency using this method may be due to general unfamiliarity of the estimators of visualizing the yield in terms of pounds per acre, although some training was done prior to estimating on a plot on which yield in pounds per acre was known to the estimators. Analytical estimates in pounds per acre, using ten-thousandth acre plots, improved consistency

of estimates on the part of two estimators, failed to improve estimates of two, and reduced the consistency of the fifth.

Before leaving the subject, there are a few points which should be touched on. First, it should be pointed out that the study is only partially complete and the data gathered to date are only indicative of final results. We might even see some reversals of present results. Weight of numbers of observations is always needed for conclusive results. Next we should like to point out that the work has been under drought conditions for the most part. Yields have been extremely low. It is only reasonable to expect that under increased rainfall, growth will be increased and that this will be reflected in better correlation of rainfall and yield and between yield and the various estimates. The highest percent of maximum yield yet observed in the study is 36. There seems to be little reason to doubt that estimators will be able to improve certain of their estimates when working with more nearly normal yields. Certainly they will have little difficulty in distinguishing normal yields from the exceedingly poor yields which have been observed thus far in the study. At the same time it should be realized that low yields should be recognized for what they are, that is correctly evaluated, so that proper grazing management can be planned accordingly.

Next we would like to briefly reconsider the matter of relation between rainfall and production. Although our results so far have shown a low degree of relationship between these two values, we do not wish to imply that this will always be true, even on the same plots which we have been observing. To date rainfall has shown comparatively little variation and stand has shown comparatively great variation between the plots, so that the variation in yield is better accounted for by variation in stand than by variation in rainfall. As time goes on and all the stands improve to high value, if they do, and we experience more varied amounts of rainfall, the yields on the plots may quite well be accounted for more by variations in rainfall than by variations in stand. On rangeland as a whole, however, where both rainfall and stand will undoubtedly continue to exhibit considerable variations, it appears that both values should be taken into account in appraising forage yield--that is, if yield is to be appraised with high consistency.

Finally, it appears from our study to date that acceptable appraisal of forage production can be made by simple but careful estimate methods, based on experience of the estimator with the range involved. We do not want to imply that we are satisfied with any of the appraisal results so far obtained; but rather that the estimate methods show promise. In practice, forage appraisal may finally be a matter of taking a method best suited to the experience, ability, and preference of an individual, and practicing with this method until results are satisfactory.

# RELATIONSHIP BETWEEN RANGE CHARACTERISTICS AND FEEDLOT AND CARCASS MERIT OF HEREFORD STEERS

R. L. Blackwell

The production of feeder cattle is the leading agricultural enterprise in the Southwest. The present methods of beef production generally require that the feeder cattle be shipped to areas of abundant feed supply for fattening. Rarely does the breeder have the opportunity to determine the relative merit of his cattle in the feedlot and in the packing house. Thus, there is a need for information on the relationships that exist between measures of performance of cattle on the range, in the feedlot, and in the packing house. Knowledge of these relationships will enable the breeder to give proper attention in selection to those traits that have the highest relationship to feedlot performance and carcass merit.

Records of approximately 500 Hereford steers that were produced on the College Ranch and fed out as long yearlings provided the data for this report. The traits that were observed under range conditions were: weaning weight, weaning grade, yearling weight, yearling grade, yearling gain, and weight per day of age. Yearling data were taken at about 18 months of age just before the steers were moved into the feedlot. The steers were fed for a period of 168 days each year, then were shipped to a central market for sale and slaughter. The feedlot traits that were studied were: final weight, average daily gain, and slaughter grade. Carcass weight, dressing percentage, and carcass grade were the measures of carcass merit. Since these data were collected over a 14-year period, the variations due to years were removed in the computation of the correlation coefficients that are presented in table 1. Age differences were not removed, however.

Table 1.-- Correlations between weaning and yearling characteristics of range steers and their feedlot performance and carcass merit

| Range characteristics | Feedlot and carcass characteristics | | | | | |
|---|---|---|---|---|---|---|
| | Final weight | Daily gain | Slaughter grade | Carcass weight | Dressing percentage | Carcass grade |
| Weaning weight | 0.484 | 0.083 | 0.130 | 0.467 | 0.159 | 0.099 |
| Weaning grade | -.019 | .013 | .202 | .013 | .063 | .091 |
| Yearling weight | .670 | .194 | .243 | .641 | .212 | .137 |
| Yearling gain | .379 | .179 | .190 | .325 | .084 | .004 |
| Yearling grade | -.008 | .039 | .220 | .001 | -.006 | .053 |
| Weight-per-day-of age 1/ | .615 | .246 | .214 | .573 | .183 | .305 |

1/ Computed at approximately 18 months of age.

The correlation coefficient gives us an idea of the degree of relationship that exists between two characteristics. For instance, a correlation of 0.5 between two traits is a fairly sizable one, but there is still a great deal of variation in one trait that is not associated with variation in the other trait. A correlation near zero means that there is essentially no relationship, while a correlation near 1.0 indicates that the relationship is very nearly perfect.

Weaning weight is moderately related, in a positive way, with final feedlot weight and with carcass weight. Undoubtedly variation in age has increased this relationship a bit. The relationships between weaning weight and the remaining feedlot and carcass characteristics were low, but positive.

Weaning grade apparently is unrelated to all traits except slaughter grade. This is true also for yearling grade. It appears that among related steers with acceptable beef type and conformation, as these cattle were, variation in grade is of little importance in predicting future merit in the feedlot or in the slaughter house. The factors that contributed to high grading cattle as calves and yearlings were of some importance in determining the slaughter grade. This is indicated by the correlations of 0.202 and 0.220. These correlations are low but significant.

Weight and gains recorded at about 18 months of age consistently were found to have substantial relationships with the feedlot and carcass characteristics. Weight per day of age and yearling weight appear to be the two best criteria to use in selection of feeder cattle in terms of predicting future performance as feeders and as slaughter cattle. In an earlier study it was found that the correlation between slaughter grade of the steers at the end of the feeding period and carcass grade was 0.44, and the correlation between feedlot gain and slaughter grade was 0.35. In this study the correlation between weight per day of age and carcass grade was 0.30.

It can be concluded that gaining ability in range cattle is positively related to the measures of feedlot performance and carcass merit considered here. Weaning and yearling grade were found to be unrelated to all traits except slaughter grade. Studies at the New Mexico Experiment Station and at other stations clearly show that the inheritance of gaining ability in cattle is such that selection can accomplish a great deal. Selection for size and rapid gains under range conditions will produce cattle that do well in the feedlot and also produce desirable carcasses. The emphasis in selection that should be placed on the various traits that can be observed under range conditions depends, in part, upon the merit of the cattle. If quality and conformation of the herd are at an acceptable level, more emphasis can be given to other traits. It appears that the breeder will gain little by attempting to improve type beyond a certain level so far as its influence on the feedlot and carcass merit of the cattle is concerned.

Table 2.-- Mean and approximate range for each characteristic

| Characteristics | Mean | Range | Characteristics | Mean | Range |
|---|---|---|---|---|---|
| Weaning weight,lb. | 425 | 184 | Final weight,lb. | 1085 | 362 |
| " grade, score | 6.0 | 3.6 | Daily gain, lb. | 2.21 | 1.4 |
| Yearling weight,lb. | 720 | 210 | Slaughter grade,score | 5.5 | 5.6 |
| " gain, lb. | 295 | 143 | Carcass weight, lb. | 612 | 250 |
| " grade,score | 6.1 | 4.0 | Dressing percentage,% | 56.9 | 9.6 |
| Wt./day-of-age,lb. | 1.3 | 0.4 | Carcass grade, score | 7.0 | 5.8 |

# THE EFFECT OF RAINFALL ON CATTLE PRODUCTION

J. H. Knox

Twenty-one years' records on the experimental ranch give a considerable amount of information about the effect of rainfall on calf crops and the weight of cattle. Everyone knows that rain makes grass and grass makes beef, but probably something can be learned from a study of these records which are shown graphically on the chart.

The 21-year period begins with 3 years near-average rainfall followed by above-average moisture from 1938 to 1944, an irregular but below-average period from 1945 to 1949, and severe drought from 1950 to the present time. There are several general observations that can be made. Rainfall late in the season may have little effect on production that year but a major effect the year following. The years 1935 and 1954 may be cited as examples. In both cases very dry summers were followed by heavy fall rains. This did not prevent calf weights being low but did result in a great increase in 1936 and 1955 in spite of rather low rainfall both years. Dry springs will not be followed by top cattle weights regardless of rainfall later in the summer. 1938, with a dry spring followed by one of the very best growing seasons, produced calves and yearlings little above average, while 1943, with a very dry spring followed by a fair growing season, produced some of the lowest gains on record. Another point worth noting is, on a properly stocked range, cattle production does not increase noticeably when rainfall is above average because average forage growth provides the feed needed by the animals. Of course, such years have great value by increasing moisture and feed reserves.

When we examine the graphs for the different phases of cattle production, we find that the curve for calf weaning weight parallels closely that for cow weight. With few minor exceptions calves do well when cows do well. Yearling gain fluctuates more widely with varying feed conditions than either cow or calf weight. In this case heifers were used instead of steers because they were available for a greater number of years. The reason yearling gain did not follow average rainfall in a few cases, such as 1942, was that the heifers all ran in one pasture which occasionally received more or less than average moisture. A thing worth noting here is that maximum yearling gain is made when thin calves are put on good pasture as in 1944. In reverse, poorest gains are made when fleshy calves are run on poor pasture as in 1952.

Perhaps the most surprising graph is the one for calving percentage. The number of calves born each year reflect conditions the previous year. Therefore the calves shown on the chart for any year are the number born the following spring. The figure shown for 1935 is actually the calves born in 1936, and so forth. Ordinary yearly variation had little effect on the number of calves born. Continuous years of low rainfall usually cause some decline as from 1950 to 1953, and critical feed conditions such as occurred in 1954 can result in very low calf crops. Calf crops can be affected by bulls

as well as the condition of the cows. This occurred in 1935 and 1952 when trouble with bulls was responsible for sags in the curve.

Nothing has been said about death loss. The records do not show a marked relationship between this factor and drought. There may have been some tendency for deaths to increase in recent years but variations appear to be due mostly to accidental causes. Except for five cows killed by lightning in 1942 and nine that died from contaminated water in 1945, cow losses have varied from zero to two a year. Calf losses have averaged above 5 percent with no apparent relationship to weather condition.

Possibly one of the most important things to be learned from these records is the quick recovery cattle make following drought. By 1936 cattle seemed to have completely recovered from the effects of 1934, and in 1955 they had largely recovered from the preceding several years of drought. In the latter case the improvement has not been continued in 1956. Cattle recover quickly from drought while range recovers slowly.

## Summary

1. Below-average rainfall usually decreases production but above-average rainfall seldom increases production on a properly stocked range.

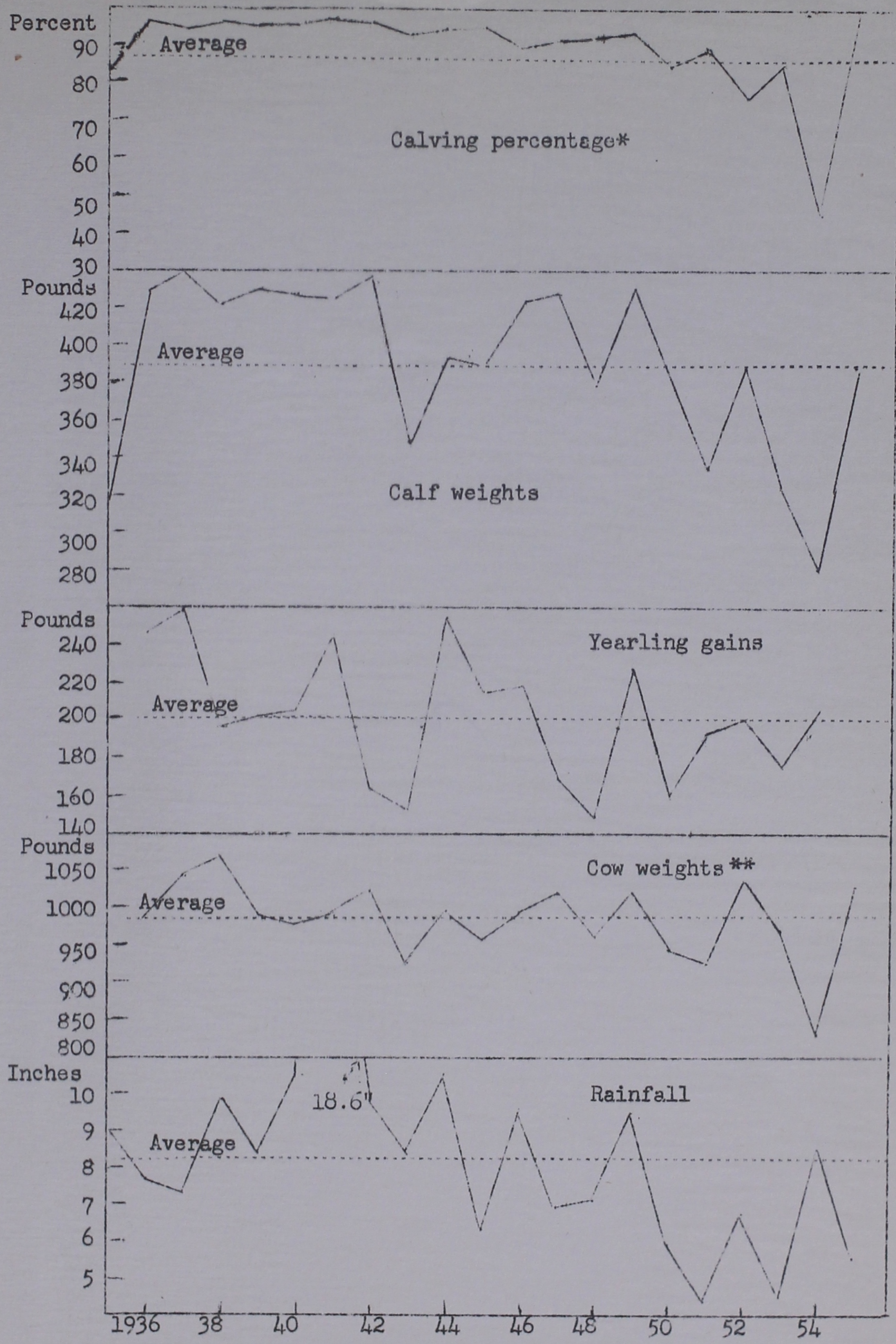
2. Good spring feed conditions are necessary for maximum cattle production regardless of the amount of moisture later.

3. Heavy fall rain has little effect on cattle weight that season, but may have a major effect on production the following year.

4. Yearling gains fluctuate more sharply with changing feed conditions than calf weights.

5. Maximum yearling gains result when good years follow bad ones and, conversely, poorest gains are obtained when bad years follow good ones.

6. The number of calves born was affected little by usual variations in rainfall. A continuous period of years with low rainfall results in some decline and the critical year of 1954 reduced the calf crop by one-half.




*For year following rainfall record.
**Cows over 4 years old with calves.

Figure 1.— Effect of rainfall on range cattle production.